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TABLE OF CONTENT

PLENARY SESSION

THE EFFECTS OF LIFE CYCLE MANAGEMENT OF ABRASIVES ON SUSTAINABLE WJ CUTTING

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Abstract
The environmental awareness and rising needs for technologies that spare costs and energy becomes main priority and driving force for competitive production strategy.
From the sustainability point of view, cost efficient process nowdays has to be also eco efficient. It is well known that water jet (WJ) technology as one representative technology for cold and high energy concentration process which offers many objectives of multi efficient manufacturing.
This work evaluates the aspects of applicability of reused abrasives in WJ cutting process. Effects of reused abrasives in terms of productivity and cut quality are evaluated and discussed within the objective of waste emission reduction. Different conceptual solutions of recycling equipment confirm the importance of life cycle management of abrasives in enabling of green manufacturing.

Keywords:
Abrasive, water jet, recycling, roughness, surface

1. Introduction

The main goal of this paper is to explore the impact of abrasives on quality of cutting with abrasive water jet (AWJ).
AWJ is relatively new non conventional cutting method which uses water under high pressure up to 6000 bar to cut various kinds of materials. Water by itself can cut only soft materials like paper, food, some kinds of plastics, etc. To increase kinetic energy which is used for cutting materials, abrasive is added.
With mixture of water and abrasive it is possible to cut thicker and harder materials like steel, aluminum, stone, ceramics, etc.
Since there is no heat impact on material being cut, the need for AWJ grows each day and many manufacturing companies replace other non conventional machines like laser or plasma with AWJ.
Cutting with water and added abrasives has a disadvantage in high abrasive costs.
During the cutting, especially thin materials, big amount of abrasive remains unused due to the circular shape of the nozzle.
Since it is possible to recycle abrasive and use it again it is necessary to investigate the quality of recycled abrasive.
Since there is a need for recycling abrasive due to cutting costs in WJ machining, influences of Barton garnet and recycled abrasive on surface roughness were investigated and compared.

2. State of the art

The cutting costs of AWJ process include cost components such as machine tool cost, abrasive cost, nozzle wear cost, wages including overhead cost and so on. Competitive AWJ cutting means low costs per hour or cutting length. In Europe, the average AWJ cutting cost per hour is high and in the range from 150 to 200(€/h), what makes difficulties on achieving competitiveness of the AWJ process. Challenge for this technology is to reduce the costs remaining the fast speed and acceptable cut quality.
In the AWJ cutting cost, the abrasive cost (including disposal cost) is usually the largest component (Figure 1). This cost share can reach from 20% up to 70% of the total cutting cost, depending on parameters such as the abrasive mass flow rate, the number of cutting heads, the abrasive price, the AWJ system's cost and so on. However, the abrasives after cutting can be reused, which can reduce the abrasive cost and the disposal cost. Conditions of recycling of GMA garnet, the most popular abrasives for blast cleaning and waterjet cutting, has not been understood satisfactory.
It is evident that the recycling of abrasives can be a good way to reduce the total cutting costs. To find an effective way for the abrasive recycling, the optimum particle size of recycled and recharged abrasives for the maximum cutting performance as well as for the minimum cutting cost should be determined. In addition, the economics of cutting with recycled and recharged abrasives must be investigated.

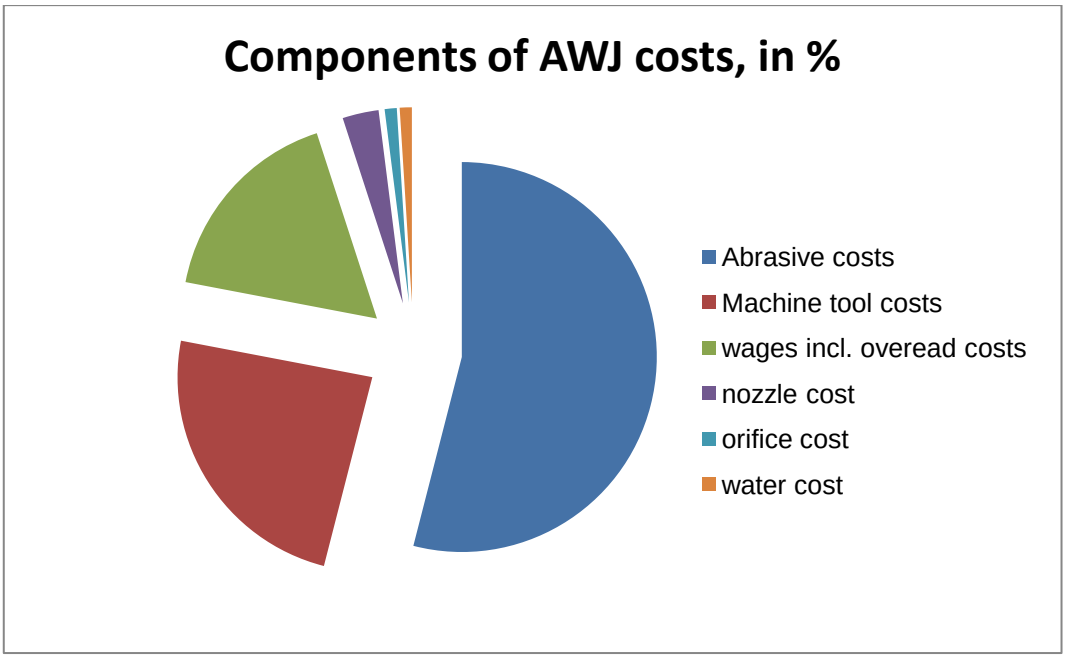

Figure 1 Components of AWJ costs

In practice recycled abrasives can be used for AWJ cutting individually as a new abrasive or used as addition to new abrasives. The process of addition of the new to the recycled abrasives is called abrasive recharging. The recharging ensures continuous addition new abrasives to maintain the maximum cutting performance constantly.

The reduction of abrasive cost as a main cost component in AWJ cutting (Figure 1) can be achieved with increasing water pressure (M. Hashish refers that 33% decreasing of abrasive costs is possible when water pressure is increased from 400 to 600 MPa). Other solution is abrasive recycling . Recycled abrasive can be used for two main applications: reconditioned - recycled for subsequent use for cutting /blast cleaning or simple use as a row material for concrete. Therefore, AWJ abrasive recycling has been the objectives of many studies.

The loss of cutting ability of abrasive particles (because of disintegration of abrasives by breaking or fragmentation) in the AWJ cutting process occurs in two stages: 1. during the mixing process (due to interactions between abrasives and the components of equipment for focusing and mixing with water and between particles with each other); 2. during the cutting process (because of the interactions between particles with the work material and particles and each other). Therefore, understanding of the fragmentation of abrasive particles is highly relevant to a study on abrasive recycling. The fragmentation of abrasive particles have been investigated in many studies, however, the optimum abrasive size for recycled abrasives and for recharged abrasives has not been refered.

J. Ohlsen [6] reported that particles smaller than 60 μm lead to a very small depth of cut, poor cutting quality and can cause abrasive clogging in the mixing head. Moreover, the author found that the cutting performance and the cutting quality of the recycled abrasives is acceptable while particle size distribution lies in the range from 125 to 180μm. This range of the particle size can lead to the maximum depth of cut and a lower surface roughness.

M. Kantha Babu and O.V. Krishnaiah Chetty [7] found that the reusability of a local garnet from Southern India (or the recycling capability which is determined by the percentage of abrasives that can be reused) with the particles larger than 90 μm is 81, 49, 26 and 15% after the first, second, third and fourth recycling, respectively . The authors [7] investigated effect of recycled abrasives of three cycles on the depth of cut, on the surface roughness and on the kerf width. It was observed that the maximum depth of cut of the first and second recycled abrasives is approximately 82 and 79% of the new abrasives. Also, cutting with the first and the second recycled abrasives can reduce both the surface roughness and the kerf cone.

The influence of the recharging on the depth of cut, on the surface roughness, and on the kerf width for cutting with aluminum was investigated by M. Kantha Babu and O.V. Krishnaiah Chetty [8]. The authors found that an increase of the added new abrasives up to 40% led to a significant increase of the depth of cut and a slight increase thereafter.

Consequently, achievement of maximum depth of cut is reached by the recharging at 40% of the recycled abrasive . It is also found that the surface roughness reaches its minimum at 60% recharging

of recycled abrasives with the size larger than 90 μm.
Also, it is reported that only a small amount of garnet is recycled [9]. Nowdays, abrasive recycling seems impracticable, while the price of new abrasives is low (in Europe, the price of GMA garnet is 0.2 to 0.3 €/kg [10]) and on the other hand an effective solution for recycling and recharging is lacking [11].

3. Abrasive types

Two different types of abrasives are used nowdays for AWJ machining.
First type with higher quality and price is abrasive mined from rocks and crushed to certain granulation. Its quality lies in sharp edges of grain which are able to cut materials faster. Even when grain cracks perhaps in two parts, both parts retain sharp edges.
Second type of abrasives, with lower quality and price is abrasive from river bottoms and beaches. Quality of that kind is lower because the constant water flow has smoothen grain edges and even when they have the same kinetic energy as the one mined from the rock, smooth edges are not able to cut material with same force.
Various comercial types of abrasives are used in AWJ cutting. G. Mort [12] noted that most of the AWJ shops use garnet (90% of the shops).
Today, the mostly used abrasives are GMA and Barton garnet named by the companies which produce them. There are also olivine, aluminum-oxide, silica sand, etc.
Experiments in this paper were made with Barton garnet, and recycled abrasive of various kinds of abrasives.
Barton garnet physical and chemical properties are shown in table 1.

4. Experimental problem statement

When cutting with AWJ there are many parameters that have influence on quality of surface being cut.
Most important are: water pressure, cutting speed, abrasive flow, but also type of abrasives, their size and shape, as well as the type of material being cut and diameter of nozzle.
Influence of cutting speed is shown in Figure 2. It can be noticed when cutting with high speed water stream bends especially in the bottom of material being cut. It results with lower quality and to be able to cut with higher speed it is recommended to use abrasive with larger grain size, for example MESH 80.

Table 1. Physical and chemical properties of Barton garnet

Chemical analysis	Silicon Dioxide (SiO2)	41.34 %
	Ferrous Oxide (FeO)	9.72 %
	Ferric Oxide (Fe2O3)	12.55 %
	Aluminum Oxide (Al2O3)	20.36 %
	Calcium Oxide (CaO)	2.97 %
	Magnesium Oxide (MgO)	12.35 %
	Manganese Oxide (MnO)	0.85 %
Physical characteristics	Hardness (Mohs)	8-9
	Melting point	1315ºC
	Specific gravity	3.9-4.1 g/cm3
	Magnetism	Slightly magnetic (volume susceptibility =9.999375).
	Particle shape	Sharp, angular, irregular
	Colour	Red to pink
	Strength	Friable to tough
	Cleavage	Pronounced laminations, irregular cleavage planes.
	Crystallization	Cubic (isometric) system as rhombic dodecahedrons or tetragonal trisoctahedrons (trapezohedrons) or in combinations of the two.
	Quartz	None
	Electrostatic properties	Mineral conductivity: 18000 volts Non-reversible
	Moisture absorption	Non-hygroscopic, inert
	Pathological effects	None
	Harmful free silica content	None (silicosis free).

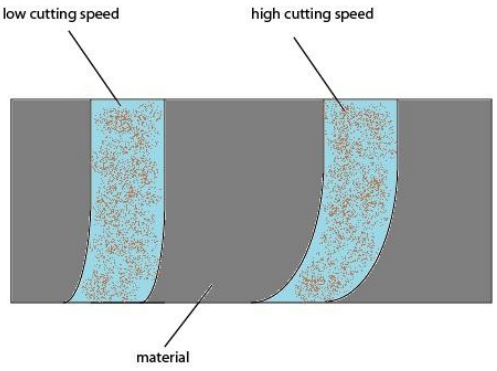

Figure 2. Stream bending dependent of cutting speed

Usually the higher water pressure results with a better quality due to the higher kinetic energy of abrasive particles. Using the higher pressure it is possible to use finer abrasive, for example recycled or MESH 120 which guarantee better surface quality.
Regarding the abrasive usage per minute, it is logical that the more abrasive we use, the higher

the speed of cutting and quality should be. But there is a certain amount of abrasive over which the quality or speed of cutting decrease. In case when the amount of added abrasive is to big water doesn´t have enough kinetic energy to accelerate abrasive particles as it could when the amount of added abrasive was lower. Also in that case the particles collide with each other which results with decreasing their kinetic energy. Due to that the abrasive flow should be optimized and adjusted to water pressure, cutting speed and type of material.
In some research, it was found that optimal abrasive load ratio (mass ratio of abrasives and water $R=m_a/m_w$) is around 20%
Abrasive particles have probably the biggest influence on surface quality because they are in direct contact with the cutting surface and it can be said that the surface is negative from abrasive particles. So if we observe the cutting surface as negative of just one particle, the size of missing material would fit the size of the particle edge which cut that material with its depth and width.
From that it can be concluded that the finer the particle is the lower the roughness will be.
Based on research of T.J. Labus [3] cutting parameters have a big influence on particles disintegration. He found out that the pressures under 205MPa have more influence on particles cracking than the pressure levels between 274 and 342MPa. He also claims that the mixing tube length does not influence on the particles but mixing chamber geometry does.
Authors have found out that the larger particles disintegrate much more than the smaller ones. Grain sizes of 180μm disintegrate on grains with size of 63μm, while the original grains between 75 and 150μm have really low level of disintegration. Of course, the large influence on abrasive disintegration have the type and the thickness of the material. Due to that, recycled abrasive is more recommended for cutting thin materials.
Disintegration of abrasive particles can be seen in Figure 3. where the original abrasive microscopic view can be seen and Figure 4. where recycled abrasive microscopic view can be seen.

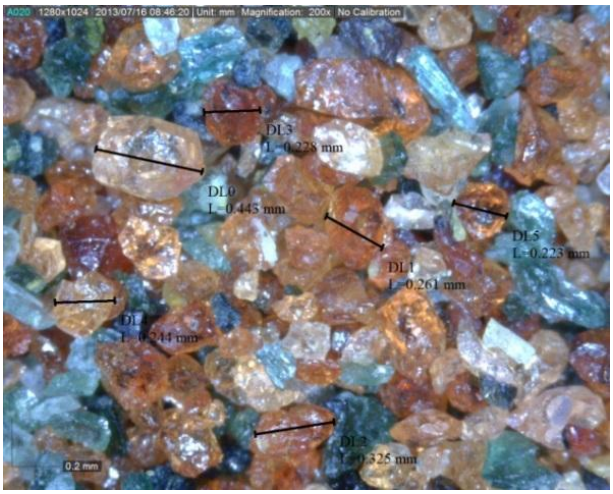

Figure 3. New abrasive


Figure 4. Recycled abrasive

It is obvious that the original abrasive has almost double size from recycled abrasive.
Very positive side of recycling is that usually recycled abrasive is cleaner than the original one, which can be explained with a fact that during the recycling, all particles that are not usable are being removed.

5. Experiment

The experiment was provided to compare the quality of surface being cut with three types of abrasive: Barton garnet MESH 80, Barton garnet MESH 120 and recycled abrasive, which was a mixture of various abrasives.
It was planned to cut rectangle shapes. By its height every sample was separated in 4 zones (5mm,11mm,19mm and 25mm). In those zones roughness was measured with device MITUTOYO SJ301 shown in Figure 5. Material used for samples was AISI 316L.
For each type of abrasive 18 measurements were made.
In every measuring three variables were changed: water pressure, cutting speed and abrasive flow.

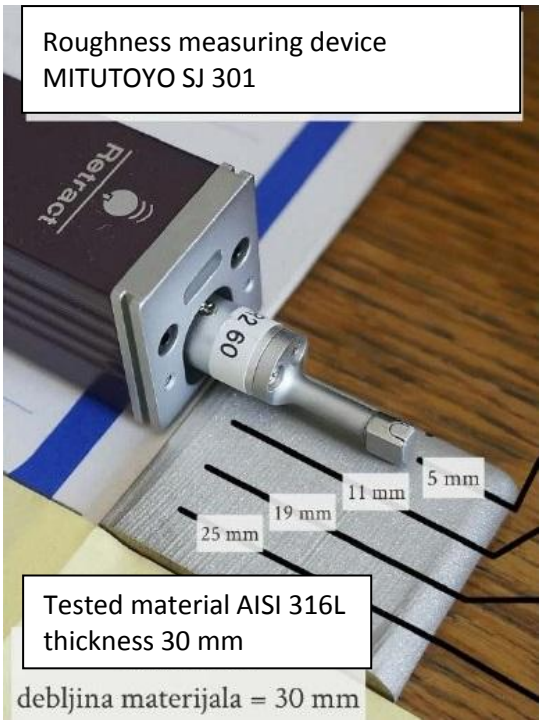

Figure 5. Experiment sample and roughness measuring device

6. Experiment results analysis

Since the material was thick, the aim was to investigate how does the certain abrasive reacts at the certain depth, and what will the impact on cutting surface roughness be.

Table 2. shows the results gained while cutting with recycled abrasive.

Table 3. shows the results gained while cutting with Barton garnet MESH 120.

Table 4. shows the results gained while cutting with Barton garnet MESH 80.

Results marked with yellow color are the best roughness results gained under same parameters when compared with all three types of abrasives.

As it can be seen in tables 2-4 under same parameters recycled abrasive has the best quality to depth of 19mm.

While thickness is higher than 19mm all of the investigated abrasives perform mostly equal.

Possible explanation of gained results is that the recycled abrasive is even finer than MESH 120, which means it has a good structure to make fine surface, but since it has been already used it disintegrates easier than the new one.

If the average results would be observed, recycled abrasive performs best, because till depth of 19mm, in most cases it has the lowest roughness.

Results gained by MESH 80 were expected because its grain is much bigger than recycled or MESH 120 so the surface has higher roughness till depth of 19mm, while the results in area of 25mm are very good and slightly better than Barton garnet MESH 120 and recycled abrasive. Possible explanation of that is disintegration of Barton garnet MESH 80 large grains into finer grains when they get to the depth of 25mm. While the grains of recycled abrasive and Barton garnet MESH 120 are completely disintegrated till depth of 25mm and have no more power to cut with the high quality, Barton garnet MESH 80 transforms into MESH 120 at the depth of 25mm.

Table 2. Recycled abrasive roughness results

	Factor 1	Factor 2	Factor 3	Response 1	Response 2	Response 3	Response 4
Run	A: Pressure	B: Cutting speed	C: Abrasive flow	Roughness 5 mm	Roughness 11 mm	Roughness 19 mm	Roughness 25 mm
	bar	mm/min	kg/min	Ra, µm	Ra, µm	Ra, µm	Ra, µm
1	3250	30	0.40	2.66	3.7	6.09	10.25
2	3400	35	0.35	2.51	3.82	5.8	12.43
3	3250	30	0.50	2.43	3.3	5.3	9
4	3000	30	0.40	2.94	4.14	5.73	15
5	3400	25	0.45	2.13	2.99	4.73	5.19
6	3400	35	0.45	2.42	3.8	5.5	11.24
7	3250	30	0.40	2.46	3.53	5.83	8.69
8	3100	25	0.35	2.38	3.64	5.02	6.88
9	3100	35	0.35	3.25	4.24	6.54	16.78
10	3250	22	0.40	1.92	2.9	4	4.18
11	3250	30	0.40	2.61	3.43	5.12	9.44
12	3250	30	0.30	2.9	4.2	6.27	13.46
13	3400	25	0.35	2.26	3.15	4.8	5.67
14	3500	30	0.40	1.98	3.53	5	8.3
15	3250	38	0.40	3.3	4.5	7	17.94
16	3250	30	0.40	2.64	3.8	5.5	9
17	3100	25	0.45	2.33	3.48	4.9	5.78
18	3100	35	0.45	3.06	4.1	5.9	16.46

Table 3. Barton garnet MESH 120 roughness results

	Factor 1	Factor 2	Factor 3	Response 1	Response 2	Response 3	Response 4
Run	A: Pressure	B: Cutting speed	C: Abrasive flow	Roughness 5 mm	Roughness 11 mm	Roughness 19 mm	Roughness 25 mm
	bar	mm/min	kg/min	Ra, µm	Ra, µm	Ra, µm	Ra, µm
1	3250	30	0.40	2.81	3.6	7.67	14.66
2	3400	35	0.35	2.88	4.67	6.47	6.57
3	3250	30	0.50	2.7	3.71	8.19	17.84
4	3000	30	0.40	2.85	4.64	6.36	6.98
5	3400	25	0.45	2.26	3.18	8.06	15.92
6	3400	35	0.45	2.71	3.83	7.01	10.97
7	3250	30	0.40	2.58	3.84	6.07	8.19
8	3100	25	0.35	2.55	3.79	7.2	10.33
9	3100	35	0.35	3.17	4.81	5.22	5.94
10	3250	22	0.40	2.1	2.8	6.35	9.9
11	3250	30	0.40	2.71	3.85	7.08	13.23
12	3250	30	0.30	2.94	4.43	8.96	15.47
13	3400	25	0.35	2.35	3.54	6.73	9.42
14	3500	30	0.40	2.68	3.7	7.78	15.7
15	3250	38	0.40	3.03	4.93	5.46	4.91
16	3250	30	0.40	2.74	4.37	7.45	14.52
17	3100	25	0.45	2.47	3.74	5.89	6.64
18	3100	35	0.45	3.08	4.38	6.79	9.04

Table 4. Barton garnet MESH 80 roughness results

	Factor 1	Factor 2	Factor 3	Response 1	Response 2	Response 3	Response 4
Run	A: Pressure	B: Cutting speed	C: Abrasive flow	Roughness 5 mm	Roughness 11 mm	Roughness 19 mm	Roughness 25 mm
	bar	mm/min	kg/min	Ra, µm	Ra, µm	Ra, µm	Ra, µm
1	3250	30	0.40	3.28	5.21	5.57	7.7
2	3400	35	0.35	2.86	4.17	6.91	12.97
3	3250	30	0.50	3.38	5.68	5.46	6.78
4	3000	30	0.40	2.78	3.53	6.53	12.75
5	3400	25	0.45	3	5.34	4.77	5.34
6	3400	35	0.45	2.99	4.63	6.07	9.19
7	3250	30	0.40	2.85	4.51	6.13	7.69
8	3100	25	0.35	2.95	4.71	5.73	6.92
9	3100	35	0.35	2.49	3.15	7.08	13.87
10	3250	22	0.40	3.06	4.35	4.74	4.93
11	3250	30	0.40	3.1	4.9	6.22	8.57
12	3250	30	0.30	3.45	5.46	5.85	12.57
13	3400	25	0.35	2.95	4.49	5.59	6.02
14	3500	30	0.40	3.13	4.91	5.78	7.56
15	3250	38	0.40	2.45	3.4	7.48	14.77
16	3250	30	0.40	2.92	4.88	5.46	10.76
17	3100	25	0.45	2.67	4.35	4.93	5.44
18	3100	35	0.45	2.8	3.97	6.97	13.46

7. Conclusion

Due to the growing need for increasing AWJ industry competitiveness it is necessary to investigate all possible solutions for cutting manufacturing costs. Since the abrasive cost is higher than all other costs in AWJ machining this paper should used as a guide for abrasive recycling profitability. Recycling is profitable if the amount of used abrasive is big enough as well as if the quality is the same or nearly the same as it is with new abrasive. As this paper is analyzing quality aspect of recycling, with the results gained in experiment it can be concluded that the quality of recycled abrasive is satisfying for manufacturers which cut thin materials up to 19mm, if it is profitable from economical side also. In that way they not only save money on recycling, but they get product with higher quality too.

Since the recycled abrasive has the ability to cut thick materials also, but with lower quality, recycling can also be profitable for this group of manufacturers because they can save money on recycling too.

Acknowledgement

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MODERN APPLICATION OF UV-VIS SPECTROSCOPY IN AGRICULTURE

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Abstract
Ultraviolet (UV) and Visible (VIS) spectroscopy is a powerful technique based on absorption of ultraviolet or visible part of electromagnetic spectrum during the interactions with matter. Due to its broad range of applications the methods arising from UV-VIS spectroscopy are vastly used in different chemical and clinical laboratories worldwide. Both qualitative and quantitative analyses can be performed in order to gain valuable information on analyte structure and identification although quantitative analyses are more frequently used. In recent years applications of UV-VIS in agronomy continuously grow and include many different aspects, such as: soil science, food science, fruit and vegetable growing, plant production and protection, oil and wine industries, etc. Some of modern applications of UV-VIS spectroscopy in field of agriculture are presented in this work.

Keywords:
UV-VIS, spectroscopy, analysis, agriculture

1. Introduction

Agricultural production has been integral part of every civilisation and society in human history as the main food production process. There are many theories and hypothesis about origins of agriculture but the organised farming certainly transformed ancient hunter-gatherer societies many thousands years ago.[1] The development of agriculture through centuries has been slow until industrial revolution and it has always been accompanied by the technological development and inventions. Contemporary agricultural production heavily depends on continuous technological and scientific progress in many fields.

Spectroscopy is the part of science that deals with light, particularly with studying of interactions between electromagnetic energy and the radiated matter. Its development in more scientific way started some 200 years ago and since then the spectroscopy has played significant role in many different scientific findings, especially in chemistry, physics and astronomy. Modern applications of various spectroscopy methods include also medicine, pharmacy, biology, marine science, environmental science, genetics, agriculture, mechanical engineering, material science, polymers, geo-sciences etc.[2,3]

The aim of this paper is present some of recent applications of UV-VIS spectroscopy in different fields of agriculture.

2. Theoretical background

Ultraviolet radiation (UV) is very small part of electromagnetic spectrum with wavelength (λ) between 10 nm and 400 nm (approximately). Visible part (VIS) of the spectrum is characterised by larger wavelength, approximately from 400 nm to 700 nm (Figure 1).

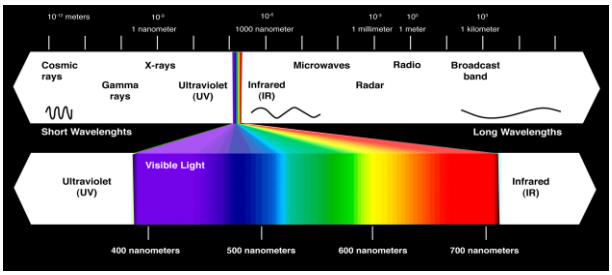

Figure 1. Electromagnetic spectrum.[4]

Electronic transitions in atoms and molecules usually occur in UV-VIS range and involve valence electrons rearrangements, not the core electrons (Figure 2).[5] These features provide a great variety of potential theoretical and practical applications of UV-VIS spectroscopy, especially as a complementary technique to other spectroscopies (IR, NMR, EPR…).[6]

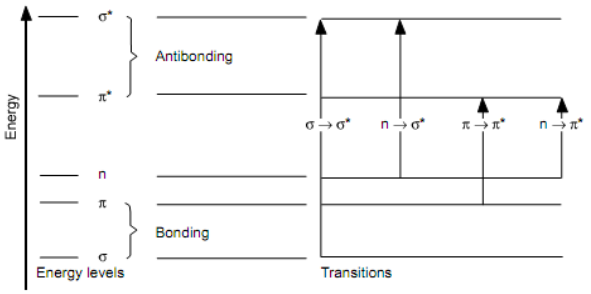

Figure 2. Electronic transitions in UV-VIS spectroscopy with involved orbitals (σ - single bonding orbitals, π - double or triple bonding orbitals, n – non-bonding orbitals).[3]

Due to the energy (frequency) characteristics of orbitals, absorptions detectable in UV-VIS range mostly involve only $\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ and $n \rightarrow \sigma^*$ transitions which can be seen as peaks in UV-VIS spectra. This qualifies unsaturated organic compounds as very good candidates for different UV-VIS measurements.
Both qualitative and quantitative measurements can be performed in UV-VIS spectroscopy. Although all physical states of matter are welcomed, experiments are mostly performed on liquid samples and the spectrometers are usually designed in that way. This seeks special attention in experiments because some solvents also absorb energy in UV-VIS range and thus have interfering effects.
Qualitative chemical analysis is based on interpretation of absorption peaks' positions and intensities (Figure 3).

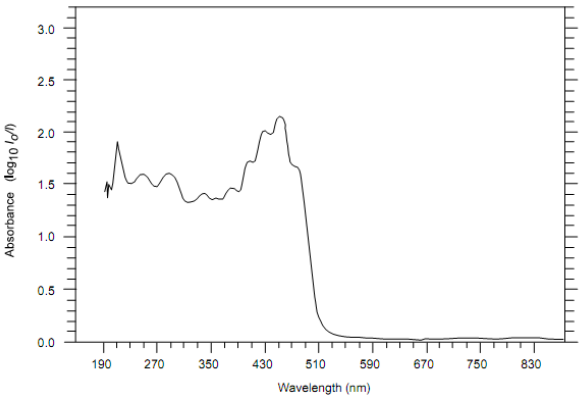

Figure 3. UV-VIS spectrum of β-carotene.[3]

Variations in peak position and intensity can occur due to the vicinity of other functional groups or due to the solvent effects and those variations can give valuable information on structure and dynamics of analysed sample.
Quantitative analysis is based on finding that intensity of light transmitted through analyte exponentially decrease with an increase in concentration of absorber or pathlength.[7] This dependence can be expressed by the following relation:

$$A = -\log \frac{I}{I_0} = \varepsilon \cdot c \cdot l \qquad (1)$$

where A is absorbance, I is intensity of transmitted radiation, I_0 is initial intensity of radiation, ε is molar extinction coefficient at certain wavelength (characteristic of each absorber) in $mol^{-1}dm^3cm^{-1}$, c is molar concentration of sample in $mol \cdot dm^{-3}$ and l is pathlength in cm. Equation 1 is often known as Beer-Lambert Law.[8] The fact that the total absorbance of sample (A_T) is an sum of absorbances of each of n compounds provides possibility of direct multicomponent samples analyses:

$$A_\Gamma = \varepsilon_1 \cdot c_1 \cdot l + \varepsilon_2 \cdot c_2 \cdot l + \cdots + \varepsilon_n \cdot c_n \cdot l \qquad (2)$$

Besides that, UV-VIS spectroscopy has wide applicability, high sensitivity, good selectivity and accuracy and it is very often easily performed.[9] The main limitation of Beer-Lambert Law is its applicability only in diluted samples (concentration smaller than 0.01 $mol \cdot dm^{-3}$). Also, some absorbing compounds can chemically or physically react with solvent and form other compounds usually with different absorbing characteristics.
Functional groups within molecule which absorb the radiation energy are called chromophores (Table 1).

Table 1. A list of some simple organic chromophores and their light absorption characteristics in hexane.[10]

Chromo-phore	Example	Excitation	λ_{max}, nm	ε, $mol^{-1}dm^3cm^{-1}$
C=C	Ethene	π –> π*	171	15000
C≡C	1-Hexyne	π –> π*	180	10000
C=O	Ethanal	n –> π* π –> π*	290 180	15 10000
C-Br C-I	Methyl bromide Methyl Iodide	n –> σ* n –> σ*	205 255	200 360

Wavelength and intensity of maximum peak can be increased by the presence of conjugation (regular alternation of single and double bond). For example, ethane ($CH_2=CH_2$) has only one double bond and absorption maximum at 185 nm with ε of 10000 $mol^{-1}dm^3cm^{-1}$. On the other hand, buta-1,3-diene ($CH_2=CH–CH=CH_2$), containing two double bonds in conjugation, has absorption maximum at 220 nm with ε = 20000 $mol^{-1}dm^3cm^{-1}$.[3]

3. Modern applications in agriculture

Wide applicability, including different fields of chemistry, biology, physics, material science, medicine, environmental science, life science etc., ensured recognition of UV-VIS spectroscopy in scientific and expert world.[2] During the last few decades its possible applications in agriculture were extensively investigated.[11-17] Some of examples are presented here.
Atomssa and Gholap characterised and determined caffeine (Figure 4) in twelve black and green tea leaves by using UV-VIS spectroscopy.[18] The optical transition properties of caffeine were measured in different decaffeination solvents (dichloromethane, water, chloroform and ethyl acetate) and the findings showed the highest optical transition in dichloromethane (Figure 5). Authors also examined extraction efficiency of caffeine by hot water with respect to extraction time and temperature. The results indicated that more

caffeine can be extracted at boiling temperature than at 30 °C.

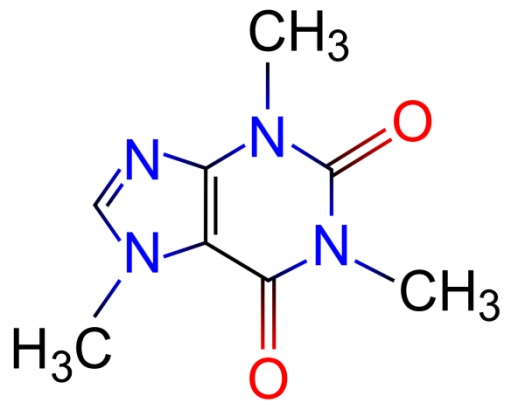

Figure 4. Structural formula of caffeine.

Kenyan black tea leaves had the greatest caffeine content (2.36%) of all examined tea leaves while the Sri Lankan green tea had the smallest caffeine content (1.34%).

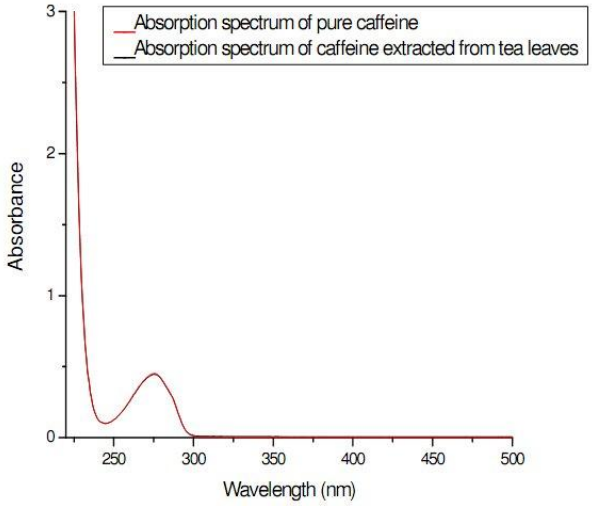

Figure 5. Absorption spectra of pure caffeine and caffeine extracted from tea leaves.[18]

The amount of pesticides in agricultural products has been measured by different methods (HPLC, GC, GC-MS…). UV-VIS spectroscopy is also suitable for determination of pesticides. Zamani reported on cheap, simple and very applicable method for systematic herbicide Picloram measurements in corn and barley (Figure 6).[19] UV-VIS experiments were performed at 405 nm with detection limit measured to 0.148 ppm. Author also believes that slight modifications in proposed method could lead to its further applicability in determination of similar herbicides (with amino group).

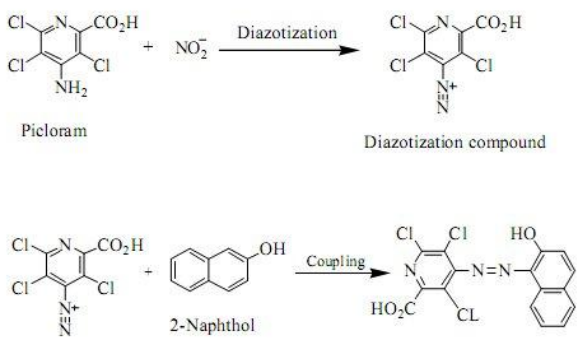

Figure 6. Diazotization and coupling in Picloram UV-VIS determination.[19]

UV-VIS spectroscopy is very useful for wine determination and classification due to its richness in number of compounds. Evaluation of geographic origin of Torrontes wines, as a part of wine authenticity process, was extensively performed by UV-VIS spectroscopy and chemometric techniques.[20] Authors analysed 16 different mono-varietal wines from 4 Argentinian provinces using principal component analysis (Figure 7), linear discriminant analysis and partial least squares discriminant analysis (Figure 8). pH values and alcohol content in wines were determined prior to spectroscopy experiments. The method is characterised by low-cost equipment and short-time analysis in comparison to other techniques.

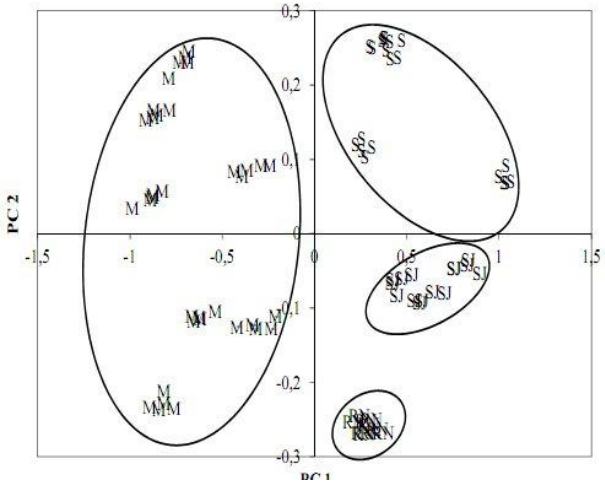

Figure 7. PCA 2D score plot of the first two principal components of Mendoza (M), Rio Negro (RN), San Juan (SJ) and Salta (S) Torrentes wines using UV-VIS spectra.[20]

The presented results have shown 100% correctness in classification of examined wines. It demonstrated potential use of UV-VIS spectroscopy with chemometric data analysis as a method for classification of Torrontes wines according to their geographical origin.

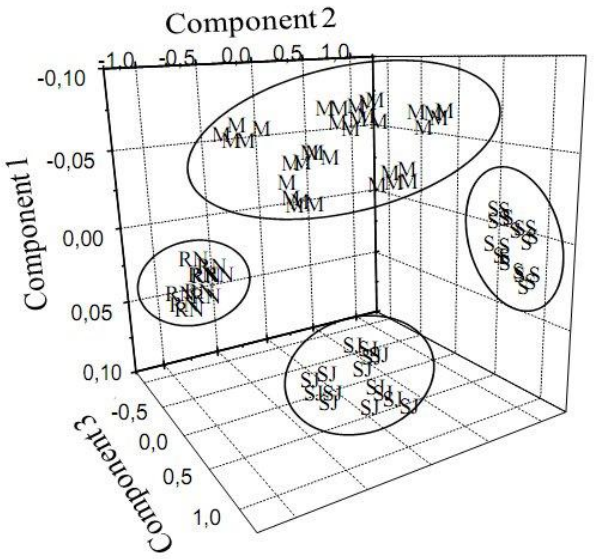

Figure 8. PLS-DA 3D score plot of the first three principal components of Mendoza (M), Rio Negro (RN), San Juan (SJ) and Salta (S) Torrentes wines using UV-VIS spectra.[20]

Other group of authors also demonstrated great applicability of UV-VIS spectroscopy in differentiation and classification of Spanish wines (both white and red), especially in the ultraviolet region of electromagnetic spectrum.[21] Their results obtained by detailed chemometric analysis of data (Figure 9) collected by UV-VIS spectra have shown 90% accuracy in classification based on origin and 75% accuracy in classification based on grape variety and ageing process. Proposed method is simple, inexpensive, not time consuming and does not require complex instrumentation for experiments.

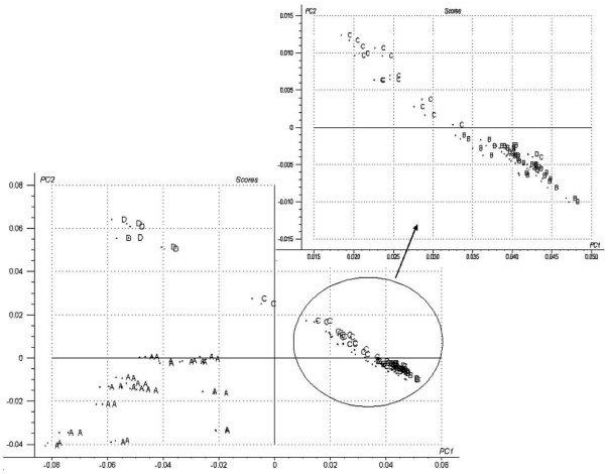

Figure 9. PCA 2D score plot of the first two principal components of Quintanar de la Orden (A), Fuente de Pedro Naharro (B), Mota del Cuervo (C) and Corral de Almaguer (D) using first derivative UV-VIS spectra of white wines.[21]

Žanetić and co-workers investigated phenolic compounds and sensorial profile of Dalmatian virgin olive oils.[22] The phenols are natural antioxidant compounds which significantly influence oxidative stability of virgin olive oils and their sensorial properties. That makes content of phenols as one of the most important parameters in quality assessment of virgin olive oils. Five indigenous varieties (Oblica, Levantinka, Lastovka, Drobnica and Mastrinka) have been studied for three years. Besides determination of free fatty acids and peroxide number, UV-VIS spectroscopy at wavelength of 750 nm was applied for total phenol content determination. Drobnica variety was found to have the highest total phenol content (Figure 10).

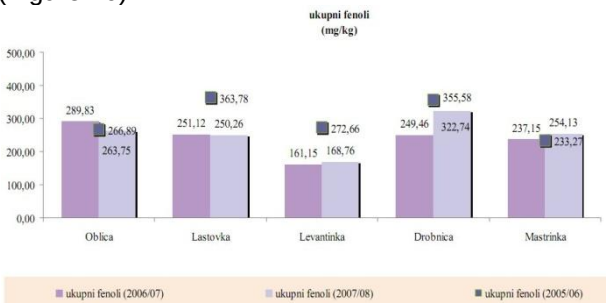

Figure 10. Average amount of total phenols (mg/kg) by varieties in three studying years.[22]

UV-VIS was also used for antioxidant activity determination with use of ABTS radical cation. The presented results proved that all samples examined have parameter *R* (absorbances at 232 nm and 270 nm) higher than 12 which is an international requirement for category “extra virgin olive oil” (Table 2).

Table 2. Basic chemical quality parameters of virgin olive oil in three years study. SMK is free fatty acids, PB is peroxide number, K values are absorbances at certain wavelength and R parameter is indicator of olive oil quality[22]

Ulje *	SMK (% kao oleinska)	PB (mmol O2/kg)	K_{232}	K_{270}	Δ K	R
Oblica	0.18±0.06	3.97±0.86	1.72±0.10	0.13±0.01	0.002±0.00	13.67
Lastovka	0.12±0.00	4.12±0.23	1.67±0.07	0.13±0.01	0.002±0.00	13.37
Levantinka	0.23±0.04	3.79±0.47	1.79±0.09	0.14±0.01	-0.006±0.01	13.22
Drobnica	0.35±0.35	3.62±0.04	1.71±0.04	0.12±0.00	0.005±0.00	14.25
Mastrinka	0.10±0.00	4.32±0.00	1.81±0.00	0.13±0.00	-0.004±0.00	13.92

UV-VIS spectroscopy is suitable for characterisation of soil humic substances (HS). Five Czech soil samples (Haplic Chernozem, Luvic Chernozem, Gleyic Luvisol, Haplic Cambisol and Leptic Cambisol) were analysed by UV-VIS and synchronous fluorescence spectroscopy.[23] The results indicated the following HS quality: Haplic Chernozem > Luvic Chernozem > Gleyic Luvisol > Haplic Cambisol > Leptic Cambisol. The highest absorbance in visible spectral range was measured for Haplic Chernozem and Luvic Chernozem. Table 2 shows total organic carbon

content and fractional composition of humus in examined soil samples.

Table 3. Total organic carbon content and fractional composition of humus in selected soil types.[23]

Sample	TOC [%]	ΣHA [mg/kg]	ΣFA [mg/kg]	HA/FA	HD [%]	F	HD* [%]	$Q_{4/6}$
1. Haplic Chernozem	2.0	6.0	2.0	3.0	30.0	0.37	30.52	4.0
2. Luvic Chernozem	1.3	4.0	2.0	2.0	31.0	0.44	29.31	3.2
3. Gleyic Luvisol	1.8	3.5	1.20	1.75	19.4	0.83	22.59	5.2
4. Haplic Cambisol	1.3	1.6	3.0	0.5	12.3	1.76	6.55	5.7
5. Leptic Cambisol	1.6	1.4	2.7	0.5	9.0	1.45	11.90	7.0

TOC – total organic carbon content, ΣHA – HA sum, ΣFA – FA sum, HA/FA ratio, HD – humification degree calculated from humus fractionation, F – fluorescence indexes, HD* – humification degree calculated from fluorescence indexes, $Q_{4/6}$ – visible color indexes.

Hidroxymethylfurfural (HMF) is an aldehide often used as quality indicator for honey. Although it is not harmful, EU limited its maximum level to 40 mg/kg (with some exceptions) by the Council Directive 2001/110/EC.[24] Two honey samples were studied by Thermo Scientific Evolution Array UV-VIS spectrophotometry and their spectra are shown in Figure 11.[25]

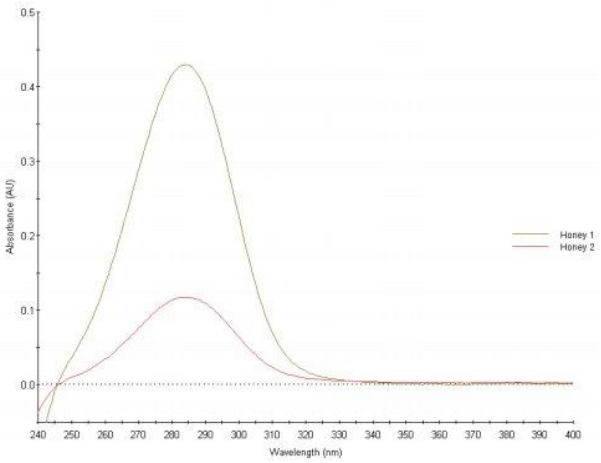

Figure 11. UV-VIS spectra of two honey samples.[25]

The content of HMF was calculated by equation including absorbances at 284 nm and 336 nm and molar absorptivity at 284 nm. The results have shown HMF content of 0.63625 mg/kg for Honey 1 and 0.16981 mg/kg for Honey 2. It means that only Honey 1 meets EU directive.

4. Conclusion

Ultraviolet and Visible spectroscopy (UV-VIS) is an instrumental technique based on absorption of ultraviolet and/or visible part of electromagnetic energy (wavelengths approximately from 10 nm to 700 nm) during its interactions with radiated matter. Both qualitative and quantitative analyses can be performed in order to gain valuable information on analyte structure, dynamics and identification. UV-VIS spectroscopy has wide applicability, high sensitivity, good selectivity and accuracy and it is often easily performed. The main limitation of Beer-Lambert Law in quantitative analysis is its applicability only in diluted samples. During the history UV-VIS spectroscopy has been applied in many filed of chemistry, biology, physics, material science, medicine, environmental science, life science etc. In recent years its applications in agriculture proved very valuable and continuously grow. They include many different aspects, such as: soil science, food science, fruit and vegetable growing, plant production and protection, oil and wine industries, heavy metals, etc.

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ENVIRONMENTAL ASPECTS OF SOIL MANAGEMENT AND MOISTURE CONTROL

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Abstract
The most important elements of sustainable development in the Carpathian Basin are the rational use and conservation of soil and water resources, maintaining their favourable "quality" and desirable multifunctionality. These are the main factors of multipurpose biomass production and environment protection: may help to prevent, eliminate or reduce extreme moisture situations (floods, waterlogging vs. droughts), unfavourable soil degradation processes limiting soil fertility/productivity, and their harmful economical/ecological/environmental/social consequences.

Keywords:
soil moisture regime, water storage, waterlogging hazard, drought sensitivity, soil moisture control

1. Introduction

The *natural conditions* (climate, water, soil and biological resources) of the Carpathian Basin (particularly lowlands and plains) are *generally favourable* for rainfed biomass production. These conditions, however, show extremely *high,* irregular, consequently hardly predictable spatial and temporal *variability;* often *extremes;* and sensitively react to various natural or human-induced stresses. The main constraints are: extreme moisture regime; soil degradation processes; and unfavourable changes in the biogeochemical cycles of elements, especially of plant nutrients and environmental pollutants [1, 2, 3].

The Carpathian Basin is a greatly *"water-dependent" region,* where the soil–water relationships considerably influence, sometimes determine the type and rate of weathering, soil formation and soil degradation processes; the moisture and substance regimes; the abiotic and biotic transport and transformation; mass and energy regimes in the „geological formation–soil–water–biota–plants–near surface atmosphere" continuum; soil fertility/productivity; the yields and yield fluctuation of crops; and environmental conditions [4].

According to the meteorological/hydrological/ ecological forecasts the risk, probability, frequency, duration and intensity of *extreme meteorological and hydrological events* will be increasing in the future and their unfavourable economical, ecological and social consequences will be more and more serious, sometimes catastrophic [5, 6, 7]. Consequently, *water* will be the determining (hopefully not limiting) factor of food security and environmental safety and the *improvement of water use efficiency* (including soil moisture control) will be the key issue of multipurpose biomass production, environment protection and sustainable social development.

2. Limited water resources and their high variability

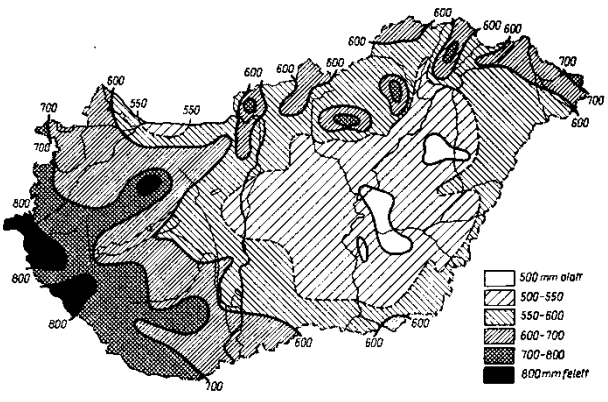
The Carpathian Basin is *generally rich* in water resources, especially in the low-lying parts of the Pannonian Plains, as the bottom of this large water catchment area. On the contrary, during certain "critical periods" in some "critical areas" the water resources are limited and "extreme" hydrological situations:

- *surplus* amount of water: flood, water-logging, "over-moistening" hazard;
- *shortage* of water: drought sensitivity

are characteristic [5, 7, 8].

The average 450–600 mm annual precipitation in the Pannonian Plains may cover the water requirement of the main crops even at high yield levels, and it gives reality for efficient "rainfed" biomass production. But the average shows *extremely high territorial* (Fig. 1A) *and temporal* (Fig. 1B, 1C and 1D) *variability* – even at micro-scale.

A



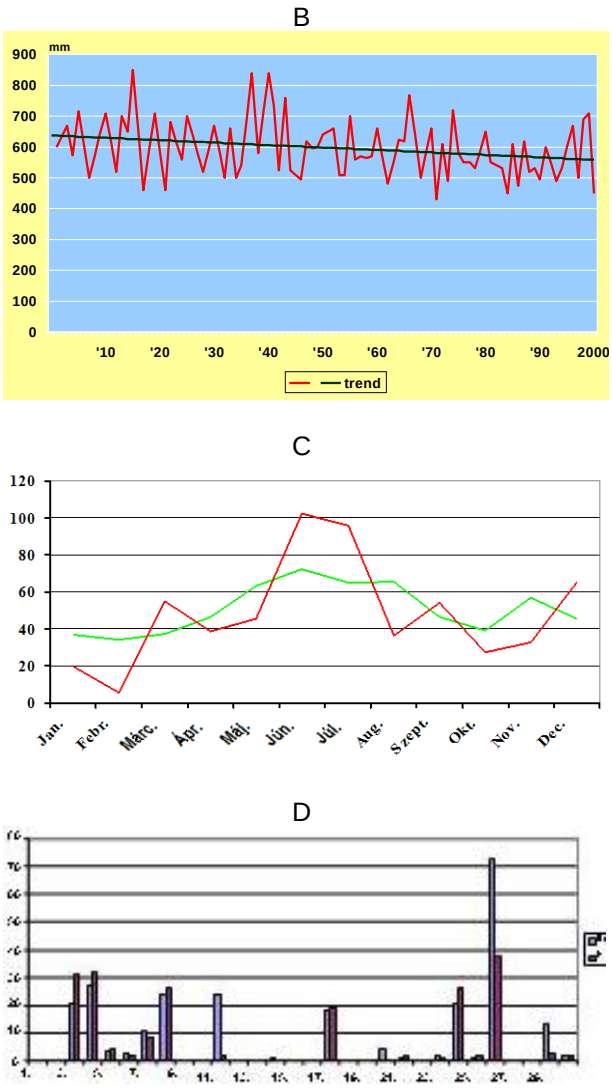


Figure 1. Territorial and time distribution of atmospheric precipitation in Hungary. A. Geographical distribution of the 100-year average annual precipitation. B. Average annual precipitation in Hungary in the 20th century. C. Monthly distribution of the long-term average and 2008 annual precipitation. D. Daily distribution of monthly precipitation (May 2008) at two nearby meteorological stations

A certain part of the atmospheric precipitation falls as highly intensive rain or hail. Their frequency, duration and intensity have considerably increased during the last years, resulting in serious environmental consequences: intense surface runoff and erosion (soil losses and sedimentation hazards) or even landslides; infrastructure damages, etc. In such cases only a limited (reduced) part of the rainwater is stored in the soil and is available for the biota, natural vegetation and cultivated crops, and giving additional water (irrigation) or draining the surplus amount of water (drainage) would be necessary. Both are faced with serious limitations in the Carpathian Basin: limited quantity of good quality water for irrigation; relief; poor horizontal and vertical drainage conditions. Therefore all efforts have to be taken to collect, store and rationally use *rainwater* and to reduce its evaporation, surface runoff and deep filtration losses [2, 7, 9, 10].

The average quantity of incoming *surface waters* (rivers) is about 110–115 km³/year in Hungary and it will not increase in the future, particularly not in the critical low-water periods, and a certain quantity and quality of transboundary surface waters must be guaranteed for the lower Danube Basin countries (at present this outflow is about 115–120 km³ [5, 6].

The "available" quantity of *subsurface waters* is also limited.

The average depth and fluctuation of the groundwater table shows great territorial variability. The possibility of capillary transport from the groundwater to the overlying soil horizons, and to the active root zone can be significant only in the lowlands [11]. This capillary transport – in the case of good-quality groundwater – may considerably contribute to the water supply of plants, decreasing drought sensitivity, as in the Small Hungarian Plain (NW Hungary). But a considerable part of subsurface waters (especially in the poorly drained East Hungarian Plain) is of poor quality (high salinity, alkalinity, sodicity) and in such cases this capillary solute transport threatens with harmful salinization/sodification processes.

Another part of the subsurface waters cannot be used or (over)exploited because of the sink of the water table and its unfavourable ecological consequences, like the serious "desertification symptoms" in the Danube–Tisza Interfluve sand plateau [7, 12].

In addition to the hardly predictable water resources, there are two more reasons of *extreme soil moisture regime*:

- the heterogeneous *microrelief* of the „flat" lowland;
- the highly variable, sometimes mosaic-like *soil cover* and the unfavourable physical and hydrophysical properties of some soils (mainly due to heavy texture, high clay and swelling clay content, or high sodium saturation: ESP) [13].

3. Soil resources, soil as the largest potential natural water storage capacity

As a result of the combined influence of the highly variable soil forming factors and soil processes a highly – even on micro-scale! – heterogeneous, *mosaic-like soil cover* developed in the Carpathian Basin.

Under the given environmental conditions it is an important fact that *soil is the largest potential natural water reservoir* (water storage capacity). The 0–100 cm soil layer potentially may store more than half of the average annual precipitation (500–

600 mm). About 50% of it is „available moisture content", which may satisfy the water requirement of the natural vegetation and cultivated crops – even at high biomass production and yield levels [1, 7, 14].

This favourable fact is quite contrary with the *high and increasing risk,* hazard, frequency and duration of *extreme hydrological events* (floods, waterlogging, over-moistening vs. drought) sometimes in the same place in the same year, which are characteristic features of the Pannonian Plains [5, 6, 12, 15]. Their *main reasons* are the high territorial and temporal variability of atmospheric precipitation; rain:snow ratio and snowmelt characteristics; relief (including microrelief); soil conditions; vegetation; land use practices. And their *main consequences* are water *losses* (evaporation, surface runoff, seepage, deep filtration); soil (organic matter and nutrients), biota, vegetation and yield *losses;* energy *losses* [2].

What are the main reasons of this "huge water storage capacity" – "extreme moisture situation" contradiction?

1.

Only (?) 31% of Hungarian soils represent an "ideal case" for the efficient use of the potential water storage capacity, having "favourable" hydrophysical properties, but 43% of the soils have unfavourable and 26% moderately favourable water management characteristics, because of various limiting factors, as it can be seen in Figure 2 [14, 17].

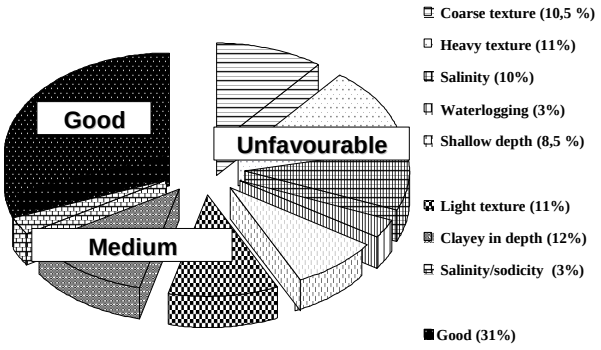


Figure 2. Water management characteristics of soils in Hungary and their reason

In the last years a comprehensive soil survey–analysis–categorization–mapping–monitoring system was developed for the exact characterization of hydrophysical properties, modelling and forecast of the water and solute regimes of soils. The digital soil physical/ hydrophysical database includes a a 1:100 000 scale map of the hydrophysical characteristics of soils. The map is shown in Figure 3 [8, 10, 17].

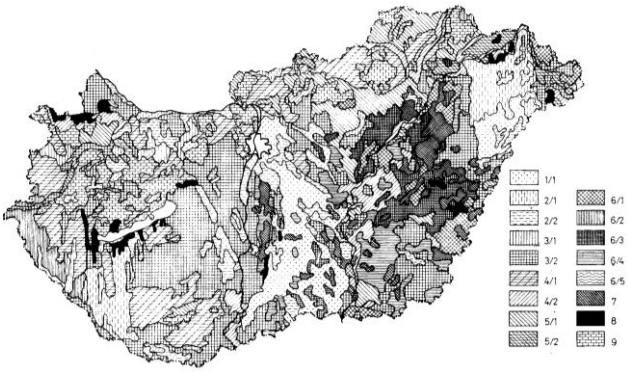


Figure 3. Hydrophysical characteristics of soils in Hungary

1. Soils with very high IR, P and HC; low FC; very poor WR. 2. Soils with high IR, P and HC; medium PC; and poor WR. 3. Soils with good IR, P and HC; good FC; and good WR. 4. Soils with moderate IR, P and HC; high FC; and good WR. 5. Soils with moderate IR, poor P and HC; high PC and high WR. 6. Soils with unfavourable water management: very low IR and K. 7. Soils with extremely unfavourable water management due to high salinity/sodicity: extremely low AMR, IR and K. 8. Soils with good IR, P and HC; and very high FC (organic soils). 9. Soils with extreme moisture regime due to shallow depth. The main profile variants: (1) texture becomes lighter with depth (soils formed on relatively light-textured parent material): 2/1, 3/1. (2) uniform texture within the profile: 1/1, 2/2, 3/2, 4/2, 5/2. (3) relative clay accumulation in the horizon B: 4/1, 5/1. Profile variants of category 6: 6/1: highly compacted, heavy-textured soils with poor structure; 6/2: pseudogleys; 6/3. deep meadow solonetzes and solonetzic meadow soils; 6/4: soils with salinity/sodicity in the deeper horizons; 6/5: peaty meadow soils

2.

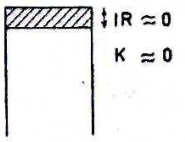
The *potential* water storage capacity is not (or only partly) utilized because of the following reasons [7, 12, 14]:

- The pore space is not "empty": it is filled up by a previous source of water (rain, melted snow, capillary transport from groundwater, irrigation etc.): "*filled bottle effect";*
- The infiltration of water (rain, melted snow) into the soil is prevented by the frozen topsoil: "*frozen bottle effect";*
- The infiltration is prevented or reduced by a nearly impermeable soil layer on, or near to the soil surface: "*closed bottle effect"* (Fig. 4 (1));
- The water retention of soil is poor and the infiltrated water is not stored in the soil, it only percolates through the soil profile: "*leaking bottle effect"* (Fig. 4 (2)).

The main reasons and consequences of these limiting factors are summarized in Figure 4.

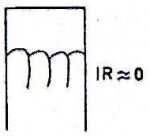
1. Limited infiltration

A. Impermeable layer (crust) on the soil surface



a) cemented by salts
– Na salts
– gypsum
b) compacted by improper soil management
– over-tillage, heavy machinery
– improper irrigation methods

B. Shallow wetting zones (low water storage capacity)

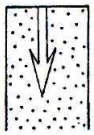


a) solid rock
b) hardpans (fragipans, duripans, orstein, ironpan etc.)
c) layer cemented by exch. Na^+, clay, $CaCO_3$ and other factors (clay-pan, concretionary horizons, petrocalcic horizons, etc.)
d) layer compacted by improper soil management (plough pans, etc.)

↓

extreme water regime
→ oversaturation (aeration problems) waterlogging problems surface runoff – water erosion
→ drought sensitivity

2. Limited water retention



IR, HC > FC → drought sensitivity

Figure 4. Limitations of using the potential water storage capacity of soil

The soil moisture regime strongly influences, sometimes determines other *soil ecological conditions,* such as air, heat and nutrient regimes, biological activity; *soil fertility;* the *environmental sensitivity* and tolerance limits of soil against various natural and human-induced stresses, including *climate change,* point source or quasi point source and diffuse *soil pollution;* and the *soil technological indices* for soil tillage and other agrotechnical operations [10, 18].

4. Soil management and moisture control

Rational land use and sustainable soil management are greatly water dependent in the Carpathian Basin [1, 4, 8, 9, 19].

As the direct moisture control actions, irrigation and drainage are faced with serious limitations (limited quantity of good quality irrigation water, relief; poor horizontal and vertical drainage conditions) all efforts have to be taken for the *improvement of "rainwater efficiency" by a "two-way" ("double face") moisture control,* which basic concept is the preference of *"storage" instead of "drainage" (transport away)!* The most important elements of such rational and *sustainable soil moisture control* are:

- help the infiltration of water into the soil;
- help the useful storage of infiltrated water within the soil without any unfavourable environmental consequences;
- reduce the immobile (strongly bound "dead") fraction of the stored water;
- reduce evaporation, surface runoff and deep filtration losses of atmospheric precipitation and irrigation water;
- drain only the harmful surplus amount of water from the soil profile and from the area, improving vertical and horizontal drainage conditions (prevention of over-saturation and/or water-logging).

There are many possibilities for the practical realization of these basic objectives. Some of them are summarized in Table 1, indicating their potential environmental impacts [4, 7, 10, 19].

Scientific and technical development offer more and more new tools, techniques and technologies for such activities on the basis of our comprehensive digital soil physical/hydrophysical database, which can be quantitatively interpreted for soil layers, soil profiles; physico-geographical, administrative, farming or mapping units (e.g. ecological region, water catchment area, county, settlement, farm, agricultural field etc.). Our task is to select and implement proper and efficient site-specific technologies. As it is clear from Table 1 most of these „moisture management actions" are – at the same time – efficient environment control measures and reduce the risk and unfavourable consequences of various natural and human-induced stresses (as soil degradation processes, nutrient stress, pollution hazard, etc.) [3, 8].

5. Concluding remarks

Soil management and soil moisture control have distinguished significance in rational land use and sustainable soil and water management in the Carpathian Basin. The present and expected increasing risk, frequency, duration and intensity of extreme (and irregular, consequently hardly predictable) climatic and hydrological events and moisture situations may result in serious (or even catastrophic) environmental damages and their unfavourable economical, ecological and social consequences. Proper and efficient soil and water management may help to prevent, eliminate or reduce these extreme hydrological situations (floods, waterlogging vs. droughts), unfavourable soil degradation processes, and their harmful

Table 1. Elements and methods of soil moisture control with their environmental impacts

Elements		Methods	Environ-mental impacts*
Reducing	surface runoff	Increase in the duration of infiltration (moderation of slopes; terracing contour ploughing; establishment of permanent and dense vegetation cover; tillage; improvement of infiltration; soil conservation farming system)	1,1a 5a, 8
	evaporation	Helping infiltration (tillage, deep loosening) Prevention of runoff and seepage, water accumulation	2,4
	feeding of ground-water by filtration losses	Increase in the water storage capacity of soil; moderation of cracking (soil reclamation); surface and subsurface water regulation	5b, 7
	rise of the water table	Minimalization of filtration losses (↑); groundwater regulation (horizontal drainage)	2,3 5b,5c
Indreas -ing	infiltration	Minimalization of surface runoff (tillage practices, deep loosening) (↑)	1,4,5a, 7
	water storage in soil in available form	Increase in the water retention of soil; adequate cropping pattern (crop selection)	4,5b,7
Irrigation		Irrigation; groundwater table regulation	4,5c,7, 9,10
Surface ⟩ drainage Subsurface		surface ⟩ moisture control (drainage) subsurface	1,2,3,5c, 6,7, 11

* Referring numbers: See below

Favourable environmental effects	Unfavourable environmental effects
Prevention, elimination, limitation or moderation of: – water erosion (1) – sedimentation (1a) – secondary salinization, alkalization (2) – peat formation, waterlogging, over-moistening (3) – drought sensitivity, cracking (4) – plant nutrient losses by: – surface runoff (→ surface waters eutrophication) (5a) – leaching (→ subsurface waters) (5b) – immobilization (5c) – formation of phytotoxic compounds (6) – "biological degradation" (7) – flood hazard (8)	– overmoistening, waterlogging, peat and swamp formation, secondary salinization/ alkalization (9) – leaching of plant nutrients (10) – drought sensitivity (11)

consequences. The proper control measures may satisfy the preconditions of soil resilience, the "quality maintenance" of this multifunctional, conditionally renewable natural resource, which are important elements of sustainable development, multipurpose biomass production and environment protection.

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AGRICULTURE AND HORTICULTURE

IMPLEMENTATION OF IRRIGATION SCHEDULING BASED ON MONITORING OF SOIL MOISTURE CONTENT IN EXTREME WEATHER CONDITIONS

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Abstract
The purpose of irrigation scheduling is to make a decision when and how much water apply to the field. There are many advantages of irrigation scheduling and one of the most important is to maximize irrigation efficiency by saving of irrigation water and energy as well. Also, there are different methods for irrigation scheduling which are consisted on several criterion. One of the most common used criterion in scientific research and agronomic practice is monitoring of soil moisture content during the period of growth. The discussion in this paper is limited to the use of electrical resistance blocks in irrigation scheduling. Furthermore, the efficiency of electrical resistance blocks in extreme weather conditions. The analysis of results indicate that proper irrigation scheduling has important role in preserving water and achieving high yields of maize, especially in extreme weather condition. Furthermore, application of electrical resistance block is useful tool in indirect measuring of resistance and soil water content.

Keywords:
Irrigation, scheduling, electrical resistance block, extreme weather

1. Introduction

Irrigation scheduling can be described as management process used by irrigator managers in order to determine the frequency and duration of watering. As it has been presented by Brouwer [1] "The irrigation schedule indicates how much irrigation water has to be given to the crop, and how often or when this water is given". It is the strategy which can prevent over application of water and minimizing yield loss due to water shortage or drought stress. Several negative consequence can come as a result of excess water applied thru irrigation system: oxygen deprivation, impaired root respiration, infection by disease organism and most of all it comes to yield reduction, nutrient leaching and economical losses. Several studies in different environmental condition have shown that irrigation practice contributes to NO_3^- contamination of surface and ground water [2], [3], [4], and [5]. Authors claim that it is important application of irrigation water and nitrogen fertilizers to meet but not exceed crop requirements, while prudent irrigation scheduling minimizes nutrient leaching and maximizes irrigation efficiency by reducing energy and water use. On the other hand scientific researchers are mostly focused on yield reduction under drought stressed condition, especially in sub humid and arid areas [6], [7], [8], [9], [10]. According to some previous analysis made by Šoštarić [10] area of eastern Croatia with highly intensive agricultural production is affected by changes in climate and global environmental conditions. Eastern Croatia has experienced increases in air temperatures during last 12 years (2010-2012) which amount up to 2.2 0C (2012) in compare to long term average (LTA = 1961-1990). As it has been presented in Figure 1. in same period the amount of rainfall in several years was significantly above LTA (2001, 2005 and 2010) yet there are 6 years with drought stressed condition when yields of summer crops where extremely low (2000, 2003, 2007, 2009, 2011 and 2012).

Furthermore, not only there was significant lack of rainfall but also uneven distribution of rainfall during period of growth. Therefore implementation of irrigation scheduling in sub humid area (eastern Croatia) is required. Different methods for irrigation scheduling are demanding different approach. One of the most common criterion is monitoring of soil moisture content. There are varieties of methods that can be used to measure soil water content. The discussion in this paper is limited to the use of electrical resistance blocks in maize irrigation scheduling performed at Agricultural institute in Osijek. The aim of this paper is to review the current knowledge and previously published papers on the importance of irrigation scheduling

for better water usage in extreme weather conditions.

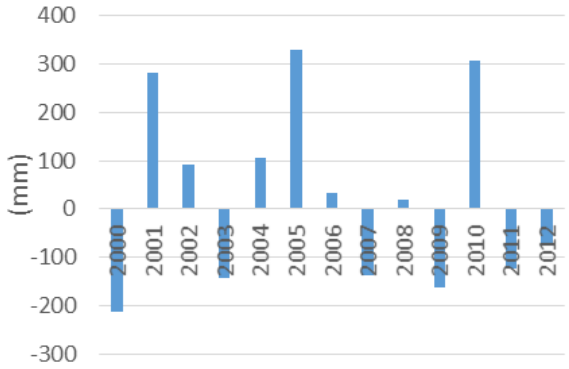

Figure 1. Variation of rainfall amounts (mm) for Osijek area in growth period 2000-2012

2. Results and discussion

Electrical resistance block

Monitoring of soil moisture content includes different devices (time domain reflectometry (TDR), tensiometers, gravimetric method, neutron probe and electrical resistance blocks) for indirect measuring of soil-water status. Electrical resistance block (Watermark block) is made of gypsum (gypsum block) and it consist two electrodes enclosed in block. Electrodes are connected to a wires extend to the soil surface (Figure 2). Wires are one meter long what provides installation to different layers in soil.

Figure 2. Electrical resistance block (Watermark block, Irrometer Co.)

Electrical resistance block actually measures soil water tension expressed in cbar. The change in soil moisture causes the change in water content of block so the electrical resistance increases as the water content of block decreases. The readings are taken by hand held device – Watermark meter, Irrometer Co. (Figure 3) and they range from 0 to 199 cbar were 0 represents water content at field capacity (FC) while 199 is the dry soil. Zero reading indicates to nearly saturated soil which means that almost no energy is required to remove water. Field capacity is upper limit of water storage. It can be defined as the condition that exists after a saturated soil is allowed to drain to the point where the pull of gravity is no longer sufficient to remove any additional water. Opposite to FC is permanent wilting point, the lowest moisture level at which plant cannot recover the drought stress.

Figure 3. Watermark sensor

Irrigation should be scheduled between these two values. The effectiveness of electrical sensor is soil condition dependent [11]. Reading result can be related to the soil water content by making a calibration curve because the relationship between soil water content and soil water potential is different for each soil type. In general, greater the clay content, greater water content at any water potential. Irmak et. al. [12] had stated that in sandy soil most of the pores are relatively large and once the large pores are emptied only small amount of water remains. For a fine, sandy soils very small increase in matric potential causes a more drastic decrease in water content then in other soil types. Beside the texture it is important to have a knowledge about main soil characteristics. Table 1. presents main physical properties of soil at trial field of Agricultural institute in Osijek.

Table 1. Main physical soil properties

SD (cm)	WC (%)	P (%)	AC (%)	p (g cm^{-3})	CC,%
0-32	36.6	41.8	5.3	1.50	0-40
32-50	37.1	41.8	6.2	1.54	28%
WC=water capacity; P=porosity; AC=air capacity, ρ= soil density; CC = Clay content, %					

Results of irrigation scheduling in extreme weather conditions

For the purpose of analysis of irrigation efficiency (IE) in extreme weather conditions yield results from previously published articles are used [13]. Water use efficiency (WUE) of maize is function of multiple factors including physiological characteristics of maize, genotype, soil characteristics like soil water holding capacity, meteorological conditions and agronomic practices [14]. Since water use efficiency (WUE) in its strictest sense does not take into account the role of irrigation, definition of "Irrigation Water Use Efficiency" by Howell [15] is more suitable for agronomic perspective because its take irrigation into account. Irrigation Water Use Efficiency (IWUE) takes into account variation in yield of the same crop under different application of water [15]. The analysis of WUE is calculated as follows:

$$WUE = \frac{Y}{ET} \qquad (1)$$

Where WUE is water use efficiency (kg mm^{-1}), Y = yield of maize grain (kg ha^{-1}) and ET = actual evapotranspiration from seeding to harvest (mm), [17]. Irrigation water use efficiency is calculated as follows:

$$IWUE = \frac{(Yi - Yd)}{Imm} \qquad (2)$$

Where IWUE = irrigation water use efficiency (kg mm ha^{-1}, Yi = yield of maize grain in irrigated conditions (kg ha^{-1}), Yd = yield at rainfed plots (kg ha^{-1}) and Imm = irrigation water (mm), [18]. Results of monitoring of soil moisture content are in close connection with weather conditions, particularly the amount of rainfall and distribution of rainfall in growing season as well. Amount of water added in one irrigation interval was same for all years and irrigation regimes, 35 mm. Total amount of irrigation water was soil moisture dependent. Total amount of irrigation water added in each irrigation regimes (A2 and A3) as well as yields of maize grain are presented in table 2. There are significant variation in amount of rainfall in selected years. For example significant lack of rainfall with drought stressed conditions was noticed in growing seasons 2007 and 2009. Opposite to that, growing season 2010 was extremely rainy with stress caused by excessive amount of rainfall. At dry farming WUE ranged from 14.28 kg mm-1 (2008) to 16.48 kg mm-1 (2006). At A2 irrigation plots WUE ranged from 16.21 kg mm-1 (2007) to 18.94 kg mm-1 (2009) while at A3 WUE ranged from 16.90 kg mm-1 (2008) to 20.82 kg mm^{-1} (2010). According to results of analysis the lower amount of plant available water the better is WUE since the highest WUE in all tested years is actually in year with the lowest amount of rainfall (2009 = 230.8 mm). Same result is in irrigated plots where the highest WUE is also recorded in 2009 at A3 irrigation plots with 240 mm of irrigation water which is the highest amount in all tested years. Furthermore, the analysis of IWUE shows better water use at A2 irrigation plots in average years 2006 and 2008 while in dry growing seasons 2007 and 2009 better water use is at full irrigated plots (A3). This result is opposite to one published by Takac [17]. Author has stated that the highest IWUE in dry years was obtained when low irrigation dosage were applied.

The exception in this research is extremely rainy growing season 2010 when the highest yield of maize grain was at dry farming plots so according to that the lowest water use was at full irrigated plots (A3). Although the Watermark measuring results have shown water deficit in upper soil layer (30 cm) as it seems irrigation water have disturbed oxygen balance and air exchange which have resulted with yield losses.

Table 2. Efficiency of irrigation scheduling in different climate conditions

Irrigation regime	A1	A2	A3
2006 - Y	8.5	9.3	9.6
IW (mm)	413.9	80	120
WUE	16.48	18.03	18.62
IWUE	-	10	9.2
2007 - Y	8.4	9.2	10.8
IW (mm)	301.7	120	200
WUE	14.80	16.21	19.03
IWUE	-	6.7	12
2008 - Y	8.2	8.9	9.2
IW (mm)	437.3	80	120
WUE	14.28	16.35	16.90
IWUE	-	8.8	8.3
2009 - Y	10.3	10.6	11.7
IW (mm)	230.8	200	240
WUE	18.41	18.94	20.91
IWUE	-	1.5	5.8
2010 - Y	9.24	9.17	8.59
IW (mm)	676.6	35	105
WUE	16.44	16.31	15.28
IWUE		-2	-6.19

A1 = dry farming; A2 = 60-100% FC; A3 = 80- 100% FC; Y = Yield (t ha^{-1}); IW = irrigation water (mm); WUE = kg mm^{-1}; IWUE = irrigation water use efficiency (kg ha/mm^{-1})

5. Conclusion

The analysis of maize yields in irrigated conditions during four growing seasons have shown:

- Eastern Croatia (Osijek) area is affected by changes in climate and global environmental conditions in which during dry and average growing seasons irrigation scheduling could be recommended as the efficient management measure to improve water use efficiency and irrigation water use efficiency,
- Accurate irrigation scheduling based upon electrical resistance blocks is useful in improved water use efficiency.
- Water use efficiency as well as irrigation water use efficiency is not only crop and irrigation system dependent but also weather and soil conditions.

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THE INFLUENCE OF PRUNING ON VINE YIELD (*VITIS VINIFERA* L.)

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Abstract
This research evaluates influence of three different pruning practices on grape yield on two different vine varieties. Researched varieties were Hamburg Muscat and Slankamenka, with different load (12, 20, 28) of buds. The biggest average yield of grapes was on Hamburg Muscat variety with 28 buds load, and the smallest yield of grapes was on Slankamenka variety with 12 buds load. The biggest average weight of grape was at Hamburg Muscat variety with 20 buds load, and the smallest average weight of grape was on Slankamenka variety with 12 buds load.

Keywords:
pruning, buds load, vine yield, Slankamenka, Hamburg Muscat

1. Introduction

The vine is a perennial woody climbing plant that belongs to the family *Vitaceae*. It originates from the vicinity of the Caspian Sea or southern Europe, and is one of the oldest cultivated crops. It is assumed that the culture of growing noble vines on Croatian shores were brought by Greek colonists, while credits for its expansion into the area of present-day continental Croatia go to Illyrians, Celts, Thracians, Greeks and Romans as well. One vine can take an acre of land and generate large quantities of low-quality grape. Fertility of vine is defined in literature by many terms: the elements of fertility, fertility ratio, indicators of fertility, etc. [1].

The amount of leaf area and its direct exposure to the sun is associated with variety and climatic region where the grapes are grown [2]. It is also known that manual pruning can rejuvenate older vineyards with fertility falling through three methods of pruning and leaf removal in two terms with the insured yield and quality [3].

The study of seven different methods of pruning was aimed to demonstrate which one fits the best for Cardinal variety. Based on two years research it is proven that method of pruning with 20 buds (2 spurs with 2 buds and 2 canes with 8 buds) has the highest yield [4].

In order to ensure gender and vegetative potential and quality of grape pruning is needed to form and maintain a breeding form. Pruning of vines belongs to agritechnical operations, which are performed in the vineyards from resting stage and during the growing phase. In order to accurately determine the required number of buds which must be untouched during the mature pruning it is necessary to know the coefficient of yield and average cluster weight for a variety that is grown.

The aim of this study was to determine the effect of different methods of pruning and loading of the vine in two grapevine cultivars (Muscat Hamburg and Slankamenka).

2. Materials and methods

Vineyard where the research was conducted was raised in 1972 and located in Bukovacko hill in Bukovlje, which belongs to the region of the continental Croatia, subregion of Slavonia. The altitude at which the vineyard is located is 185 meters, with south exposure. Vineyard area is 0.25 ha. The vine varieties in the vineyard are Italian Riesling, Rheine Riesling, Hamburg Muscat Slankamenka, Cardinal, Portuguese and Blue Franconian, and all varieties are planted in two-armed breeding form. Spacing between rows is 2.40 m and between the vines is 1 m. Vineyard is regularly fostered by agricultural equipment (sprayers, cutters, double plow).

Investigation of three different ways of pruning and different load per vine was conducted on two vine varieties. Varieties were Hamburg Muscat (Treatment A) and Slankamenka (Treatment B). The mature pruning is done on 23/03/2012.

The first pruning method was with a load of 12 buds (2 spurs with 2 buds and 1 canes with 8 buds per vine), subtreatment 1.

Another way of cutting was with a load of 20 buds (2 spurs with 2 buds and 2 canes with 8 buds per vine), subtreatment 2.

The third method of pruning was with a load of 28 buds (2 spurs with 2 buds and 3 canes with 8 buds per vine), subtreatment 3.

Yields are determined by the following parameters:
a) the total number of clusters - (for each variety in the study four vines were examined and the total and average number of bunches per vine is given),
b) the average yield per vine and average weight (g) of berries - (average weight of clusters per vine in four replications of each variety, the average

weight of 20 berries with four vine for each variety in the study).

3. Results and discussion

Table 1 shows the results obtained by analysing the total number of clusters and the average number of clusters per vine as well as average yield and average weight of berries.

Table 1. Analysis of the total number of clusters, the number of clusters per vine, average yield and average weight of berries

Treatments and subtreatmeans	A1	A2	A3	B1	B2	B3
Total number of clusters	39	93	137	42	136	156
Average number of clusters per vine	9.75	23.25	34.25	10.5	34	39
Average yield per vine (kg)	1.25	4.25	5.12	0.87	4.37	5.0
Average weight of berries (g)	2.55	2.7	2.5	2.45	2.6	2.5

In the analysis of the total number of clusters in the treatment of a variety Hamburg Muscat the largest number of clusters is determined in subtreatment A3 (137 clusters) and the average number of clusters per vine was also the largest in subtreatment A3 (34.25 clusters).

In the Treatment B (variety Slankamenka) the total number of clusters was the largest in subtreatment B3 and totalled 156, while the average number of clusters was also the largest in subtreatment B3 (39). Subtreatment B3 was also significant by the largest load. The smallest total number of clusters and the average number of clusters in Treatments A and B was in subtreatments with minimum load (A1 and B1).

In analysis of the average yield of clusters per vine in kg for the treatment of a variety Hamburg Muscat the largest average yield of clusters was obtained in subtreatment A3 with 5.12 kg of clusters, and the average weight of berries was highest in subtreatment A2 and was 2.7 g.

In the Treatment B (variety Slankamenka) the average yield of clusters per vine was the largest in subtreatment B3 and was 5 kg and the average weight of berries was the largest in subtreatment B2 and amounted to 2.6 g. The smallest average yield of clusters per vine and average weight of berries in treatments A and B was in subtreatments with minimum load (A1 and B1).

4. Conclusion

In this work, the yield of grape vines in two varieties (Hamburg Muscat and Slankamenka) with three different ways of pruning (three loads) is determined. After analysis of the study, the following can be concluded. In subtreatments A1 and B1, in which vines carried a load of only 12 buds on both cultivars, it is proved to be too small load because yield of clusters or berry size were not satisfactory. With a load of vines with 28 buds in subtreatments A3 and B3 cluster yield and berry size gave the satisfactory results.

It is harmful and economically unjustified to load vines in good condition with too small a number of buds. But in contrast to previous statement, very long pruning and the large vine load, especially young vines, can result with signs of low rise and fertility (yield) in the following year. By the end of the stage of the greatest vine growth potential (between 7 to 15 years), yield gradually decreases and at that age more care about moderate pruning must be taken. Also, fertilisation of vineyard should be more regular and better balanced by NPK fertilizers and microelements.

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THE IMPACT OF DIFFERENT ROOTING MEDIA IN THE PROPAGATION OF SOME GRAPE VARIETIES

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Abstract
Container propagation method is likely to produce high value biological material. Various rooting media play an important role in the formation of adventitious roots and in the development of the plant. Rooting ability of different grape varieties is different. There are some so called recalcitrant varieties that root poorly. This problem was examined in the experiments. The experiment was set in the College Faculty of Horticulture of the Kecskemét College. Three kinds of rooting media were used: perlite, peat and their 1-1 mixture. Sterile perlite is cheap and, although there is no nutritional content in it, positively affects rooting in the first stage. Peat has a better water-holding capacity, but it is more expensive. It may therefore be interesting to mix the two rooting media. After rooting we started fertigation of the plants. The rooted varieties were: Kadarka, Jupiter and Pannon frankos. Kadarka is an old Hungarian grape variety which very well endures poor sandy soils. Jupiter is a seedless table grape variety that also tolerates minor nutrient and water supply capacity sand soils. Pannon franc is a resistant variety of Vitis amurensis origin. Vitis amurensis varieties are known to have worse rooting ability. The different media did not affect the root mass of the plants, but Pannon frankos developed significantly shorter shoots. Out of the three varieties Kadarka gave the most consistent results. In all the six repetitions peat proved to be the best, followed by the peat + perlite mixture. In Pannon frankos varieties peat + perlite mixture gave the best results while in Jupiter variety peat and peat + perlite media gave nearly the same results.

Keywords:
grapevine, potted propagation, rooting media, perlite, turf, recalcitrant varieties

1. Introduction

The profit of grape nursery depends on the percentage of propagation material obtained. This is especially true of the graft because of the high price.
We can increase profitability by producing potted material even if the intensive propagation generates additional costs. We can plant potted plants anytime during the growing season. It is advisable to plant when the shoots reach a length of 25-30 cm. If we continue to leave the rooted cuttings in the container the roots can no longer develop. As container planting material is prepared in the greenhouse before transplanting it is necessary to adjust the plant to the lower-humidity and UV light more content. The roots are intact in the containers, the apex can quickly grow quickly. The roots of field-grown rooted cuttings or graft are cut back when they are removed from the soil. Due to the root regeneration the development of the plant drops. Potted plants bear fruit a year earlier in the vineyard [2].
An important requirement for rooting media is that it should contain sufficient water and sterile, be free from infectious source and be airy [4b].
Peat: cuttings develop root in it very well, the root system is densely branched. It can absorb large amounts of water and still remain airy.
Perlite: is commonly used in soil mixes because it improves the structure of the mix.
Mixture of peat and perlite: both mediums contain enough air, have good water holding ability. Peat fiber improves the structure of the mixture [3].

2. Production technology

To produce new vines for early summer planting in the same year, hardwood cuttings can be rooted in containers from middle of March until the end of June in the greenhouse. This method saves one year in the propagation of new vines over conventional outdoor rooting methods.
For greenhouse propagation, we take cuttings from healthy vines of the desired cultivars in early December before any major winter damage has occurred to the wood or buds. We make two- to four-node cuttings as described in the previous section, and then tie the cuttings in bundles, place in polyethylene bags, and store at 0-+4 Celsius.
In early March, cuttings are removed from storage and inserted into a suitable rooting medium in the greenhouse. Vermiculite or peat/perlite is excellent for rooting because of their freedom from weed seeds and diseases. Sand or mixtures of sand and peat are also satisfactory.
Before insertion into rooting media, the lower ends of the cuttings can be dipped in a commercial rooting hormone such as indolebutyric acid. However, rooting hormones are generally not

needed. Plastic bags of about 2 litre capacity are filled with media. Cuttings are planted so that the lower cut and node are pushed down to near the bottom of the flat or bed with the upper bud extended just above the media surface. Plastic bags (container) with wood cuttings are placed in beds on the floor [4a].
As soon as the cuttings are in place, we mist them intermittently to maintain a high and constant relative humidity during the rooting period. A mist system that operates automatically for approximately 6 seconds every 6 to 10 minutes during the day is satisfactory. The duration and frequency of the mist may need to be adjusted as the cuttings begin to grow shoots and to account for sunny or cloudy conditions. The mist can be turned off at night.
Bottom heat provided by heating cable under the flats or in the bottom of a bench hastens rooting. Rooting is most satisfactory if day temperatures in the greenhouse are maintained between 20 and 25 Celsius and night temperatures around 18 Celsius.
Usually, the cuttings develop roots and leaves within four to six weeks. At this time, the rooted cuttings can be transplanted into bigger pots for easy transplanting to the field later. A suitable mixture for filling the pots is 1/3 peat, 1/3 sand, and 1/3 soil. Another alternative is a premixed commercial potting soil. Steam sterilization of the soil mixture before filling the pots prevents weed growth and diseases.
After the rooted cuttings have been potted, we place them back under the mist for a few days to allow the roots to become established in the new medium. Once established, the plants should be moved to a conventional area in the greenhouse. Moderate temperatures of 20-25 Celsius encourage growth of new vines.
The vines must be watered regularly and receive weekly applications of a dilute fertilizer solution to maintain growth. The fertilizer solution should contain nitrogen, phosphorus, and potassium. Minor elements are also desirable, depending on the potting mix used. Slow-release fertilizer mixes are also available and can be incorporated into the soil before transplanting [1].
Plants are ready for setting in the vineyard when new shoots are about 20-30 cm long. If plant growth becomes excessive in the greenhouse, lower temperatures must be used to slow growth and harden the vines before they are taken to the field. During the hardening-off period, maintain night temperatures at 10-15 Celsius and day temperatures at 20-25 Celsius. Regardless of the state of growth, new vines should not be transplanted until all hazard of frost is past (usually end of May). Greenhouse-grown plants are extremely sensitive to frost.
The entire process also can be carried out in individual pots or elongated rooting containers by using peat and perlite or a commercial potting mix and placing the cuttings directly in the containers under mist as described earlier.
Regularly we inspect cuttings in the greenhouse for insects and diseases. Mites and powdery mildew can be troublesome pests. To eliminate these pests, use an appropriate pesticide according to label directions [4a].

3. Material and method

Three kinds of rooting media were used: perlite, peat and their 1-1 mixture. Sterile perlite is the cheapest and, although there is no nutritional content in it, positively affects rooting in the first stage. Peat has a better water-holding capacity, but it is more expensive. It may therefore be interesting to mix the two rooting media. After rooting the plants were fertigated. The varieties examined were: Kadarka, Jupiter and Pannon frankos. Kadarka is an old Hungarian grape variety which very well endures poor sandy soils. Jupiter is a seedless table grape variety that also tolerates minor nutrient and water supply capacity sand soils. Pannon franc is a resistant variety of Vitis amurensis origin. Vitis amurensis varieties are known to have worse rooting ability. The media did not affect plants' root mass, but Pannon frankos developed significantly shorter shoots.
The research was evaluated in 17 June 2014. The weight of root mass and shoot length were measured. Roots were cut off the root trunk and measured. The main shoot was also measured.

Kadarka Jupiter Pannon frankos

Figure 1. Grapevine cultivars of the research

4. Results

Figure 2 shows that turf showed the best result, but One way ANOVA proved that there are no significant differences between media as for root mass.
Root weight was significantly different in Kadarka cultivar in accordance to rooting media (Table 1). Turf proved to be the best media according to Tukey test. In the two other cultivars no significant difference was observed. The cultivars were not compared because it was not relevant in our research.
As far as shoot length perlite+turf induced the longest shoots (see Figure 3). According to one-

way ANOVA this difference is significant. In perlite shoots were significantly shorter than in turf and turf-perlite mix (Table 2).

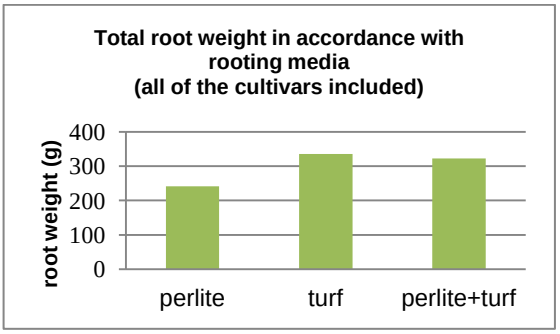

Figure 2. The effect of media on root mass weight

Table 1. One-way ANOVA of Kadarka root weight in accordance with media

	SQ	df	MQ	F	Sig.
Between Groups	512,57	2	256,28	11,55	,001
Within Groups	332,70	15	22,18		
Total	845,28	17			

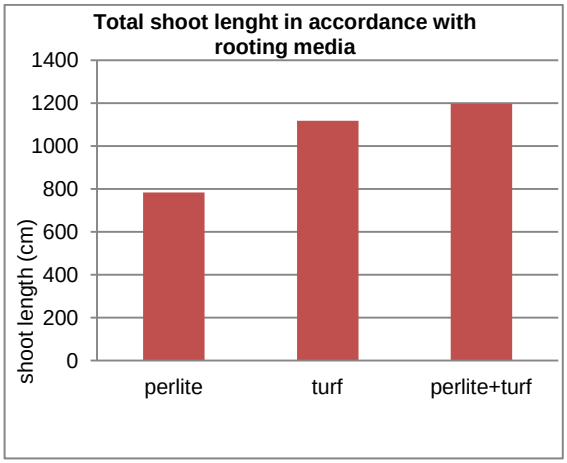

Figure 3. The effect of media on shoot length

Table 2. One-way ANOVA of shoot length in accordance with media

	SQ	df	MQ	F	Sig.
Between Groups	5321,92	2	2660,9	9,64	,000
Within Groups	14066,66	51	275,81		
Total	19388,59	53			

5. Conclusions

Different grapevine varieties can have different rooting ability. This was the case in Pannon frankos cultivar which showed a poorer rooting To offer a cultivar specific rooting technology could be offered, but the number of combinations is too many. Therefore this was not the main concept of the research. We wanted to know whether rooting media influences the development of adventitious roots, development of shooting system that is the development of the propagation material.

Root weight was not different in the rooting media as far as all the cultivars were concerned, whereas the shooting system differed in the three media. In peat shoot length was significantly less. It is an interesting phenomenon. Root system and shoot system correlate in all kind of plant species, but this was not observed in this research. The structure of the roots is important to consider. We took photos of the roots and saw the Pannon frankos has intensive root system while Kadarka and Jupiter developed less but stronger roots. This will be an important issue in the vineyard. If the soil of the vineyard is shallow but rich in nutrients intensive roots are favourable while in poor soil roots have to penetrate deep in the soil and extensive roots are more favourable. Root system is also cultivar specific regardless of the media.

As for Kadarka peat proved to be the best media in all the six repetitions, followed by the peat + perlite mixture.

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PEA (*PISUM SATIVUM* L.) SEEDLINGS PROPERTIES UNDER INFLUENCE OF DIFFERENT TEMPERATURES

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Abstract
Seed quality determination has been conducted by various laboratory tests under optimal conditions therefore correlation with field results is questioned. To determine seed germination and seed properties (root length, hypocotyl length, length and mass of the seedling) in different agro ecological conditions an experiment with two cultivars of pees (Wonder van Amerika, Kelvedon wonder) in controlled conditions on higher and lower temperatures (10 °C and 20 °C) and with lightening schedule (12 hours light, 12 hours dark). Rolled paper towel method has been used where the paper was moisturized with plumbing water (pH7). There have been four repetitions with 50 seeds for every tested variation and measurement on 8th day and analyzed with 2-factorial variance analyzes with F and LSD test. Relations between tested parameters has been checked with correlation analyzes. Significant influence of tasted parameters (sort and temperature) on seedling properties has been determined as well as correlation between root length and hypocotyl length with mass and length of seedling. Average highest values have been determined for Wonder van Amerika and higher temperature. Due to age of seeds a significantly lower germination has been observed in comparison with declared ones (on package declaration).

Keywords:
Pea (Pisum sativum L.), pH reaction, temperature

1. Introduction

Seeds are fundamental and starting point of most of the horticultural crops including most vegetables crops. Base for high yields and quality of vegetables is good seeding material and germinability of seeds. Development of the seedlings and field stand establishment are problems that producers are dealing with especially in early period when temperature can be low, soil moisture high and pH reaction of the soil unfavorable. Seed germination and development are under the influence of many factors such as: seed genotype, quality of seed (vigor and vitality) and environmental conditions which dominate through the period of seed germination and development of seedlings.

The most important quality for vegetable crops is seed quality which means early germination, uniformity and vital seedlings, early and high yield from every seed no mater of breeding conditions. Poor seed germination and slow development of seedlings are restrictive factors in agricultural production which results with adversely field stand establishment, unequal maturation no mater of optimal environmental conditions. (Gerson, Hanna, 1978, McGrady, Cotter, 1984, Cavero, 1995) [1].
Sowing of the low quality seeds (low vigor) even in optimal conditions or sowing of high quality seeds (high vigor) in less favorable conditions results with prolonged germination and development period. [1]. Seed quality is a complex feature constitute of genetic, physical, physiologic and health conditions characteristics [2], cit. [3] which are under agro ecological conditions during development and maturation of seed [4], seed processing [5], and storage conditions [6] when if it is prolonged germination is getting lower [7], [8]. Reliable and equal plant development is necessary for successful horticultural production [9], [10], [11], [12]. Seeds of horticultural crop that are sowing on the open field such as pea (*Pisum sativum* L.) are oft exposed to different and changing eviromental conditions during germination, establishment and seedlings development. A few enviromental conditions and physiological factors of the seeds interact through early mentioned stages and contribute to success of plant production [13], [14]. Soil moisture, structure and drainage combined with favorable water supply, oxygen supply and favorable temperature support germination and field establishment [15], [16], [12]. The plant producers prefer early breeding because it boosts yield and price per unit. That is a period of early spring when soil is cold and moisture which are favorable conditions for pathogen development. Pea (*Pisum sativum* L.) is a crop which can germination in a wide range of soil temperature. Optimal soil temperature is 20 °C. Germination speed rise with temperature. On the temperatures higher than 25 °C, germination decline. On the other hand on 16 °C seeds germination slower and for seedlings in a good condition and well developed at least the 18 °C is needed.

Optimal average temperature for pea growth should be between 13 °C and 18 °C. Growth stops at 29 °C [1]. Early and equal germination with appropriate growth and development of seedlings are crucial stages for commercial producers of most of the horticultural crops especially with direct sowing because of possible germination and seedlings development decrease under low temperatures (Bennett, 1992.) [1]. Standard germination test determines viability of seeds [17]. Germination test is used for determination of percentage of seeds that is able to germinate and to develop into normal seedling under optimal laboratory conditions [18]. Germination is characteristic used for determine quality of seeds. Testing the germination in laboratory environment is conducted under optimal conditions where the percentage of germination is usually higher than in the field conditions especially in cold and moisture soil with extreme soil pH reaction [3].
The aim of this research was to determine influence of pea cultivar and temperature in laboratory conditions on germination, length of roots and hypocotyl, length and mass of seedlings for estimation of cultivar tolerance on stress conditions in early stage of development.

2. Method

Investigation of seeds and seedlings properties of two cultivars of green pea (Wonder van America and Kelvedon wonder) was conducted on standard seeds under controled conditions during March 2013. The test was established under the scheme of 50 seeds in four repetitions for every temperature (10 °C i 20 °C). Germination was conducted by „rolled paper towel method“ moistured with water with pH 7. Rolled filter paper with seeds was placed in PVC bags in climate chambers (12 hours light, 12 hours dark). The results were scan on the 8th day from the begining of the test. On seedlings that were germinated the length of roots and hypocotil as well as average mass of seedling have been measured and total lentgh of seedlings have been calculated. Results were analysed with 2-factorial variance analyses by programe package SAS [19] under GLM procedure and ANOVA procedure with applied F and LSD test. Correlation between analysed indicators was examine by correlation analyses.

3. Results and Discussion

The investigation of green pea seeds and seedlings properties was conducted under cultivars Wonder van Amerika and Kelvedon wonder with declared germination of 82 % and 84 %, mass of 1000 seeds 242 g for cultivar Wonder van Amerika and 239.4 g cultivar Kelvedon wonder. Signifficans of influence of investigatted treatments on investigated prioperties of the seeds and seedlings was shown in Table 1.

Table 1. Signifficance of cultivar (C) and temperature (T) influence on seed germination and seedling properties of pea seedlings

Treatman	Germination (%)	Lenght of root (cm)	Lenght of hypocotil (cm)	Lenght of seedling (cm)	Mass of seedling (g)
C	n.s.	14.57*	17.50*	19.88*	n.s.
T	n.s.	462.80**	93.41**	351.42**	23.03*

* P≤0,05
** P≤0,01
n.s. – no significant

Germination for investigated cultivars was lower than declared (min. 43 %, max. 50 %) which was expected regarding the age and way of manipulation before it reached to the costumer. Standars seed was used in this investigation bought in garden shop with expired date at the end of 2014. About this subject a lot of investigators reported so far and their reports were simmilar to those in our research. Lower germination was measured on pea seeds 33 months old (61.5 %) in comparison with pea seeds 24 months old (70.88 %) with statistically significance (p=0,01) [20].

In other investigation standard germination of pea seeds after 21 months of storage was 90 % and after 9 months 94.5 % [21]. Our results for pea seed germination pointed that germination was not depended of investigated treatments although it was higher on higher temperatures for 1 % than those on lower temperature and for the cultivar Wonder van Amerika the germination was 2 % higher (Figure1). Those results can be consequence of huge presence of pathogens which was noted in other investigations.

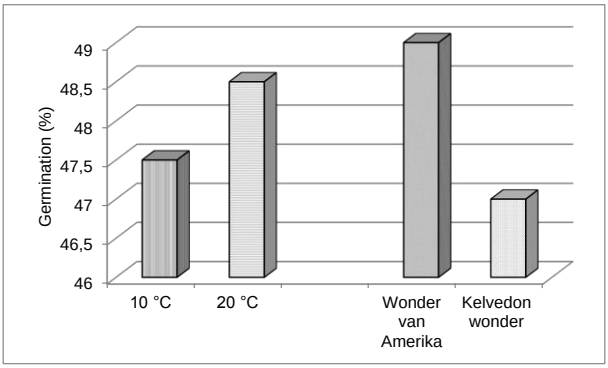


Figure 1. Influece of temeperature and cultivar on germination

The length of root was between 1.67 cm and 8.59 cm and depended largely of investigated treatments (Table 1.). In average, for investigated temperatures (Figure 2.), the length of roots was 4.85 cm longer on 20 °C than on 10 °C (LSD 1.3179) which is in accordance with researches of temperature influence on fine bean legumes [22], [23]. There was also a significant influence of cultivar on measured parameter what confirms numbers of quotes about influence of genotype on seeds properties [3]. Cultivar Wonder van Amerika had 0.86 cm longer root for both investigated temperatures (LSD 0.718).
Cultivar Wonder van Amerika had 4.88 cm, and cultivar Kelvedon wonder 4.82 cm longer root length (P≤0,01) on higher investigated temperature (Figure 3).

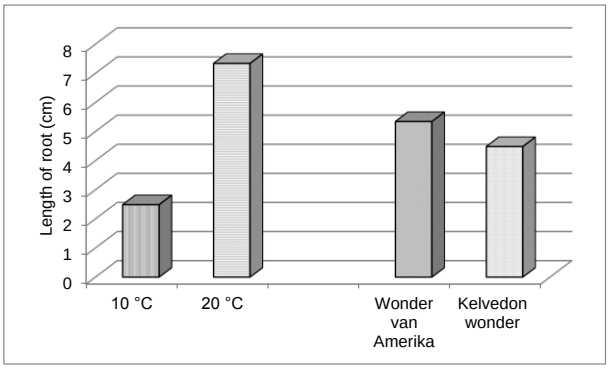


Figure 2. Influence of temperature and cultivar on root length

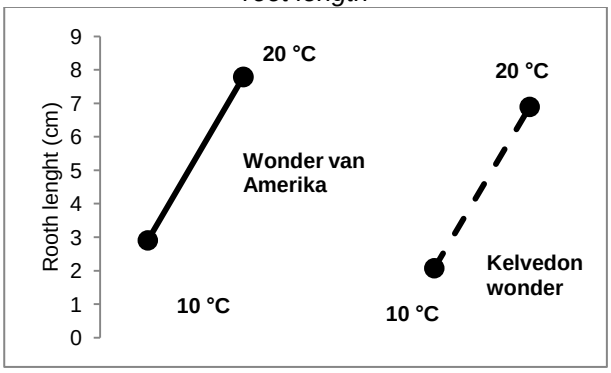


Figure 3. Influence of temperature and cultivar on root length

The length of hypocotyl depended of investigated treatments (Table 1.). Signifficantly (LSD 0.9092) longer hypocotil (for 1.50 cm) has developed on higher investigated temperatures on booth cultivars (Figure 4.). For both investigated temperatures cultivar Wonder van Amerika developed longer hypocotil for 0.65 cm (LSD 0.4954). Results simmilar with these has been determied in researches of influence of the temperature on some legume germination [23], [24].

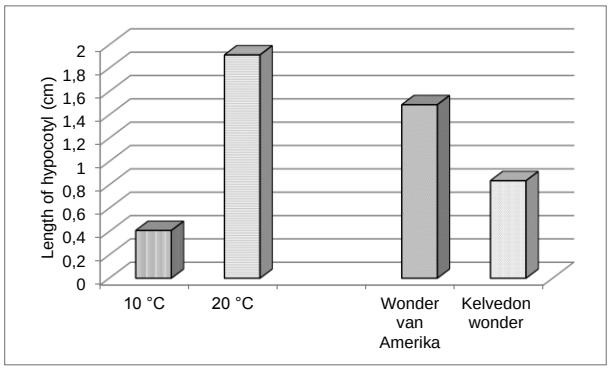


Figure 4. Influence of temperature and cultivar on hypocotyl length

On the same level of statistical significance (P≤0,01) both cultivars developed larger hypocotyls on 20 °C than on 10 °C (cultivar Wonder van Amerika for 0.97 cm, and Kelvedon wonder for 1.42 cm), Figure 5.

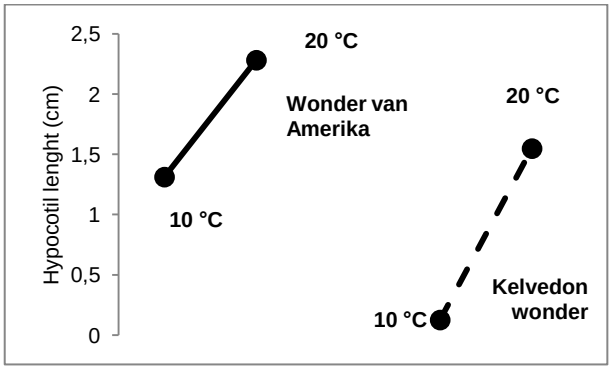


Figure 5. Influence of temperature on hypocotyl length of cultivars

The length of developed seedlings was 1.67 cm till 10.94 cm and under great influence of investigated treatments. On higher investigated temperature in average 6.36 cm longer seedling was developed (LSD 1.9811). Longer seedlings length was determine on higher temperatures on other fine bean legumes [22], [23], [24]. The influence of genotype was determined on lower level of statistical significance for average length of seedling. Cultivar Wonder van Amerika developed 1.51 cm longer seedling (LSD 1.0794) in average for both temperatures (Figure 6.).

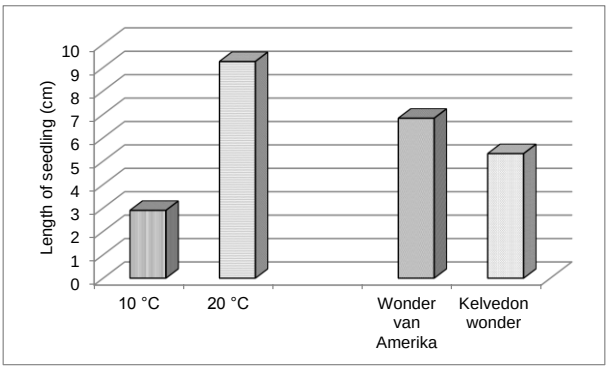


Figure 6. Influence of temperature and cultivar on seedling length

Cultivar Wonder van Amerika on higher temperature developed in average 6.47 cm longer seedling (P≤0,01), and on the same level of significance was determined influence of higher temperature on average length of seedling of cultivar Kelvedon wonder (6.25 cm), Figure 7.

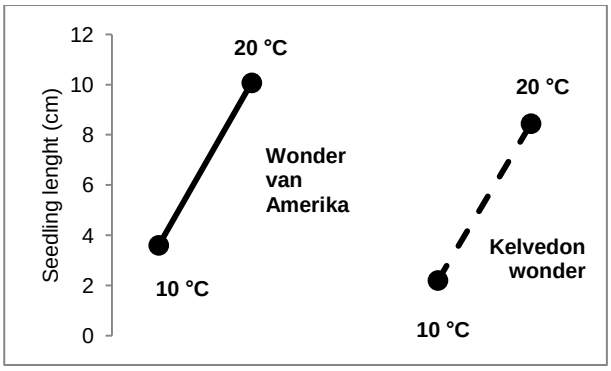


Figure 7. Influence of temperature on seedling length of cultivars

Average mass of seedlings was between 0.52 and 0.78 g. Higher average mass of seedlings for 0.12 g was measured on higher temperature for investigated cultivars (LSD 0.1427), Figure 8.

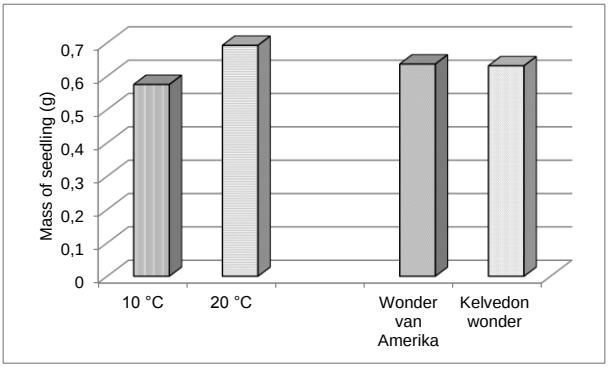


Figure 8. Influence of temperature and cultivar on seedlings mass

Seedlings mass of cultivar Wonder van Amerika was under significant influence (P≤0,01) of temperature and average seedlings mass was 0.18 g higher. Cultivar Kelvedon wonder shown no influence of temperature on average seedlings mass on the same level of statistical significance *(Figure 9.)*.

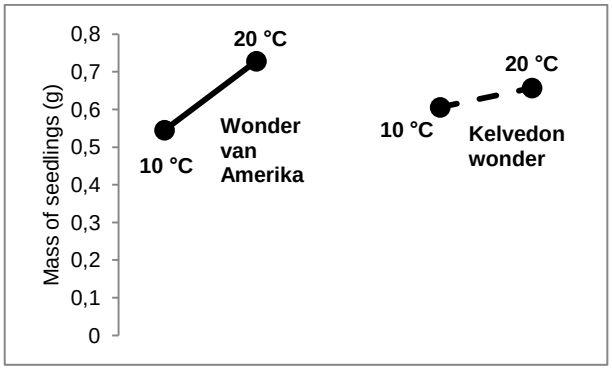
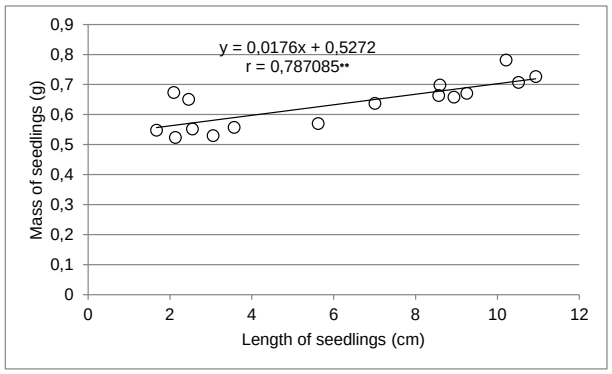


Figure 9. Influence of temperature on seedlings mass of cultivar

The firm correlation (P≤0,01) has been determined between length of root and hypocotyl for every investigated treatments (0,950156812**). There was also determined, on same level of statistical significance, correlation between mass and length of seedlings in average for all investigated treatments (Figure 10.).



**P≤0,01

Figure 10. Correlation between length of seedling and mass of seedling

4. Conclusion

Investigated properties of seed and seedlings of pea differently depended of investigated teatments. Higher values (P≤0,01) has been determined on higher temperature (20 °C) except for germination where there was no statisticaly significant influence of temperature and cultivar. Other investigated properties were under signifficant influence (P≤0,05) of cultivar where cultivar Wonder van Amerika had higher values. Values of investigated properties in particular depended of starting quality which means seed germination that was result of age and storage of seeds during transport and distribution. There was a huge presence of pathogens observed which is not the subject of this investigation.

Annotation

This paper is a part of Graduation Seminar of Ivana Vukoja, Bachelor of College of Slavonski Brod.

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RECYCLING AND DISPOSAL OF ELECTRONIC WASTE

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Abstract
"Electronic waste has become a global problem. In the World so far there are hundreds of millions of computers that have ended their working life, and it contains millions of tons of plastic, hundreds of thousands of tons of lead, thousand tons of cadmium and hundreds of tons of mercury, etc. In the near future increase in the production of electronic materials is expected as well as the amount of electronic waste materials that are often toxic and harmful to human health and the environment. In order to protect the environment in recent years new recycling technologies have emerged. For all these reasons management regulations system and regulating disposal of waste have been established. This paper presents the results of research regarding to generated electronic waste and how the same is disposed and recycled."

Keywords:
Recycling and disposal of electronic waste

1. Introduction

This paper presents the results of research and with what intensity is electronic waste generated and how the same is disposed.
Electronic waste has become a global problem. There are hundreds of millions of computers that have ended their working life, and that contains millions of tons of plastic, hundreds of thousands of tons of lead and cadmium, hundreds of tons of mercury, … [1].
The average life of a computer in 1997 was for 4-6 years; in 2005 it was reduced to two years, and today? [2].
Today, computers do not change due to deterioration or malfunction but because of the market newer and more modern versions of the device, and newer and more modern software.
Increase in e-waste and therefore the amount of waste materials that are often toxic and harmful to human health and the environment is expected.
E-waste is generated by everyone: households, small and large businesses, institutions and governments, manufacturers of original equipment...
From the above mentioned, the question arises: "Where to put the electronic waste?"
Electronic waste can be disposed of for free at recycling centers which are authorized and have permission to collect e-waste.
From the recycling yards a part of the e-waste goes to landfills, a part is recycled, some of it is incinerated, and some may be exported to Asian countries where it is recycled at lower prices because of lower labor costs.
In order to protect the environment in recent years we have seen an increased stimulation for the development of recycling technologies.
Because of all this a "waste management system" had to be established with the laws, rules and regulations regulating the disposal of waste, including electronic waste.

2. Formation of e-waste

Electrical and electronic waste (hereinafter referred to as WEEE) is waste electrical and electronic equipment, including circuit boards and components that occur in the economy (industry, trade, etc.), electrical and electronic household waste and waste electrical and electronic equipment generated in households or manufacturing and / or service activities when the type and quantity similar to WEEE from households (REGULATION ON WASTE ELECTRICAL AND ELECTRONIC DEVICES AND EQUIPMENT (NN 74/07)) [3].
According to the point of e-waste is divided into two groups:
1. WEEE from households
2. WEEE that occurs in the economy (industry, trade, etc.).
We distinguish between these types of electrical and electronic equipment (EE equipment):
• MAJOR HOUSEHOLD APPLIANCES (large refrigeration units, washing machines, dryers, dishwashing machines, electric cookers, microwave devices, electric heaters, electric fans, air conditioners ...)
• SMALL HOUSEHOLD APPLIANCES (vacuum cleaners, carpet cleaning machines, sewing equipment, irons, toasters, fryers, grinders, coffee makers, electric knives, appliances for: hair clippers, hair drying, tooth brushing, shaving, massage and other body care products, watches ...)
• INFORMATION TECHNOLOGY EQUIPMENT AND TELECOMMUNICATIONS (mainframes, personal computers, laptops, notebooks, notepads, printers, duplicating equipment, electric and electronic typewriters, fax machines, telex devices, phones, cordless phones, mobile phones,

other products or equipment telecommunication transmission of sound, images or other data)
• CONSUMER EQUIPMENT (radios, television sets, video cameras, VCRs, hi-fi equipment, audio amplifiers, musical instruments, other products or equipment for recording or reproducing sound or images ...)
• LIGHTING EQUIPMENT (luminaires for fluorescent lamps, discharge lamps, including high-pressure sodium vapor lamps with lamps and metal vapor, low pressure sodium lamps, lighting equipment and other equipment for spreading or controlling light, except incandescent bulbs ...)
• ELECTRICAL AND ELECTRONIC TOOLS (drills, saws, sewing machines, tools for riveting, nailing, bolting tools for removing rivets, nails or screws or similar uses, tools for welding, soldering and similar use equipment for spraying, loading, spraying and other different treatment of liquid or gaseous substances, tools for cutting ...)
• TOYS, LEISURE AND SPORTS EQUIPMENT (electrical kits from the tracks and cars, handheld game consoles and video games computers for biking, diving, running, rowing, etc.., sports equipment with electric or electronic components, dispensing with coins for playing ...
• MEDICAL DEVICES (radiotherapy equipment cardiology equipment, dialysis machine, lung ventilators, devices in nuclear medicine, laboratory diagnostic equipment, analyzers, freezers, other apparatus for the detection, prevention, monitoring, treatment, alleviation of disease, injury or disability ...)
• TOOLS FOR MONITORING AND MANAGEMENT (smoke detectors, heating regulators, thermostats, devices for measuring, weighing or adjust the household or laboratories. Other instruments for monitoring and control used in industrial installations (e.g. on dashboards)).
• VENDING MACHINES (automatic dispensing hot drinks, automatic dispensing hot and cold bottles or boxes, automatic dispensing of solid products, ATMs, all devices that automatically issue all kinds of products ...

Due to the rapid development of technology increasing amounts of electrical / electronic devices (cell phones, computers, ...) are used, all of these devices will, sooner or later, become waste i.e. WEEE containing many toxic substances such as:
• CADMIUM - Found in the IR readers and chip resistors. Damages kidneys, bones and is deposited in the body.
• MERCURY - Found in light bulbs and screens. Kidney damage, damages the brain and fetal development.
• BERYLLIUM - Highly carcinogenic substance. Found in motherboards.
• LEAD - Found in monitors. Adverse effect on the nervous and reproductive systems and inhibits the mental development of children and fetuses.
• HEXAVALENT CHROMIUM - It is used as a corrosion inhibitor. Causes DNA damage and asthmatic bronchitis.
• BARIUM - It is used in cathode-ray tubes. Can cause swelling of the brain, liver, heart and spleen damage.
• PVC (plastic) - Burning plastic produces toxic gas dioxin.
Therefore WEEE considered being hazardous waste.
To protect against these toxic substances, it is necessary to collect WEEE separately from household waste and disposed of in an environmentally acceptable manner.

2.1 Formation of electronic waste in the world

The amount of electronic waste in the world will grow from 48.9 million tons in 2012 to 65.4 million tons between 2012 and 2017th [4].
The waste from fast-growing economies and from Russia and other former Soviet republics exceeds the amount produced by western countries such as USA, EU, Japan, Australia in 2012.

2.2 Formation of WEEE in Croatia

According to the **"Regulations on Waste electrical and electronic devices and equipment"** importers and / or manufacturers of EE equipment are required to report on form **Importers and / or manufacturers of EE equipment (IU / PEEO)** provide information on the imported / produced output EE equipment. Data are sent monthly to the Fund for Environmental Protection and Energy Efficiency (FEPEE), annually in the Environmental Protection Agency (EPA) (until 31 January of the current year for the previous year).
The EU is estimated to produce between 8.3 million and 9.1 million tons of EE waste annually, and that by 2020 the amount of EE waste amount to will be 12.3 million tons.Well-established system of EE waste management, which is the fastest growing type of waste, will contribute to reducing the utilization of natural resources, because the treatment of EE waste results in secondary raw material for a new product.

Table 1.Information on e-waste [4].

Country	Population (total inhabitants in million)	Purchasing Power (USD per Inhabitant)	EEE Put on market (kg per inhabitant) (total in metric kilotons)		WEEE Generated (kg per inhabitant) (total in metric kilotons)	
U.S.A.	314,31	49.802,15	31,71	9.965,66	29,78	9.359,78
Japan	127,61	36.179,43	26,14	3.335,56	21,49	2.741,76
Australia	22,68	42.354,19	28,95	656,72	25,23	572,31
Germany	81,78	39.058,79	27,51	2,249.76	23,23	1.899,64
France	63,42	35.519,57	25,81	1.636,76	21,09	1.337,24
U.K.	63,07	36.727,80	26,41	1.665,41	21,82	1.375,89
Russian	141,92	17.697,53	14,85	2.107,08	10,41	1.477,66
China	1.353,82	9.146,38	8,17	11.054,87	5,36	7.253,01
India	1.223,17	3,851.31	3,57	4.362,85	2,25	2.751,84

Table 2. Produced, imported and exported quantities of EE equipment in 2011. in Croatia [5].

Type EE equipment		Production, t	Import, t	Exports, t
1.	Large and small household appliances	32,10	29 197,26	900,56
2.	Information technology equipment (IT) and telecommunications	1,26	5 672,92	351,21
3.	Consumer equipment for entertainment	0,00	4 208,30	146,72
4.	Lighting equipment	209,85	2 777,49	28,90
5.	Electrical and electronic tools (except large-scale stationary industrial tools)	0,51	2 930,61	52,49
6.	Toys, leisure and sports equipment	0,00	456,20	11,04
7.	Medical devices (except implanted devices)	3,02	319,79	0,03
8.	Monitor and control and other equipment	1,78	1411,12	22,04
TOTAL, t		248,52	46 973,69	1 512,99

3. Disposal and recycling of electronic waste

Electronic waste must first be disposed of at designated places - landfills.

It is only then that recycling / recovery of EE waste can commence.

Technological process of recycling / recovery of EE waste is divided into:

1. Dismantling of electric and electronic waste (primary treatment)

The primary treatment includes the dismantling of waste appliances and equipment and the separation of hazardous and valuable components. As a rule, it is a hand separation and waste separation. Other components of WEEE, which are made of plastic and glass are pressed

and pulverized. Dismantled and sorted waste EE devices are brought to the facility for disposal or recycling of electric and electronic waste.

Table 3. Information about EE-waste in Croatia [5].

Type EE equipment		Placed on the market, t			
		2008.	2009.	2010.	2011.
1.	Large and small household appliances	47 016,43	32 661,31	28 267,54	28 328,80
2.	Information technology equipment (IT) and telecommunications telekomunikacije	7 630,84	7 102,18	5 288,84	5 322,97
3.	Consumer equipment for entertainment	5 687,05	4 829,91	4 995,49	4 061,58
4.	Lighting equipment	4 091,88	3 279,49	2 805,70	2 958,44
5.	Electrical and electronic tools (except large-scale stationary industrial tools)	4 405,57	2 635,09	2 576,64	2 878,63
6.	Toys, leisure and sports equipment	477,25	395,73	286,29	445,16
7.	Medical devices (except implanted devices)	422,54	324,38	398,02	322,78
8.	Monitor and control and other equipment	3 272,53	2 514,55	975,52	1 390,86
TOTAL, t		73 004,09	53 742,64	45 594,04	46 706,22

2. Mechanical treatment of WEEE (secondary treatment)
Once the dangerous and beneficial components of EE waste are isolated during the primary treatment, mechanical (mechanical) shredding is next followed by magnetic separation of iron and other materials that are then separated and compressed. The material then comes to the processor where it is chopped up and transmitted to the electric separator where ferrous metals are separated from plastic. For other materials the remaining hazardous components are manually separated.
The result of recycling is valuable raw materials such as iron, copper, aluminum and brass. They are sold as a secondary raw material and brought back into the production process of new devices. This reduces the exploitation of natural resources and preserves our planet for future generations.

3.1 Disposal and recycling of electronic waste in the world

Electronic waste is disposed of in landfills where it goes to recycling. Part of the waste is incinerated, and some is used as a valuable raw material.
A certain amount of e-waste is exported to developing countries due to low cost of labor and the lack of quality of laws on environmental protection and waste disposal.
The picture shows the export routes e-waste

Figure 1. Export routes e-waste

The graph shows the amount of generated electronic waste, wastage and the amount of recycled electronic waste.

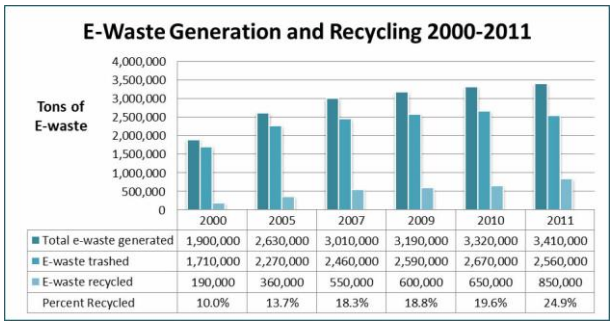

Figure 2. The graph shows the amount generated, wastage and the amount of recycled electronic waste [6].

The report does not represent all e-waste generation, but represents “selected consumer electronics” which include products such as TVs, VCRs, DVD players, video cameras, stereo systems, telephones, and computer equipment

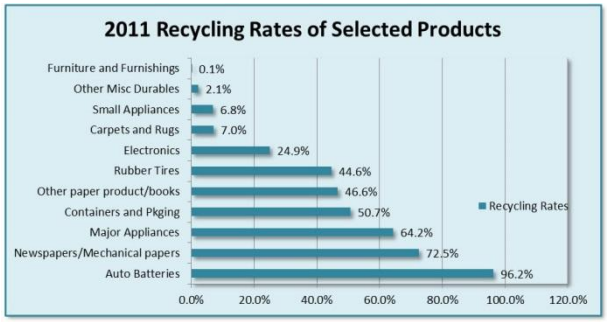

Figure 3. Recycling Rates of Selected Products [6].

3.2 Disposal and recycling of electronic waste in Croatia

LEGISLATURE

- Regulations on waste electrical and electronic devices and equipment (NN 74/07, 133/08, 31/09, 156/09)
- Ordinance on waste batteries and car battery (NN 133/06,31/09, 156/09, 45/12)
- Waste electrical and electronic equipment – WEEE DIRECTIVE 2012/19/EU
- Waste Act (NN 178/04, 111/06, 60/08, 87/09)

For disposal of electric and electronic waste in the Republic of Croatia there are authorized collection centers in counties, and for the recovery, companies concessionaires:

- CE-ZA-R Recycling center d.o.o., Zagreb
- Spectra-Media d.o.o., Zagreb

In 2011, 16,808.42 tons of EE waste was processed. In the same year reported exports of processed parts of EE waste was 4 091,75 tons.

Table 4. The combined amount of electric and electronic waste in 2011 [5].

	EE waste by type	Households,t	Other,t	Total,t	Share, %
1.	Large and small household appliances	3 251,26	4 881,06	8 132,32	46,43
2.	Information technology equipment (IT) and telecommunications	1 539,17	1 757,30	3 296,47	18,82
3.	Consumer equipment for entertainment	4 258,63	596,74	4 855,37	27,72
4.	Lighting equipment	24,07	109,33	133,40	0,76
5.	Electrical and electronic tools (except large-scale stationary industrial tools)	591,01	130,47	721,47	4,12
6.	Toys, leisure and sports equipment	19,09	48,91	68,00	0,39
7.	Medical devices (except implanted devices)	3,82	46,14	49,96	0,29
8.	Monitor and control and other equipment	13,94	115,63	247,44	1,50
	TOTAL, t	9 700,99	7 817,39	17 518,38	100,00 %

Table 5. EE waste volumes handled in 2011, the application of the concessionaire [5].

EE waste by type	Processed EE waste, t	
	CE-ZA-R d.o.o.	SPECTRA MEDIA d.o.o.
1. Large household appliances	7 748,66	0,00
2. Small appliances	0,00	282,51
3. Information technology equipment (IT) and telecommunications	0,00	2 994,27
4. Consumer equipment for entertainment	0,00	4 641,01
5. Lighting equipment	0,00	79,44
5a. Gas discharge lamps	0,00	49,47
6. Electrical and electronic tools (except large-scale stationary industrial tools	0,00	681,96
7. Toys, leisure and sports equipment	0,00	56,14
8. Medical devices (except implanted devices)	0,00	53,96
9. Equipment for monitoring and control	0,00	110,95
10. Automatic dispensers	0,00	110,05
TOTAL, t	7 748,66	9 059,76

As the amount of processed EE waste is associated with collecting amounts, processing EE waste can be positively assessed, meaning the processors have processed nearly all the received amounts of EE waste.

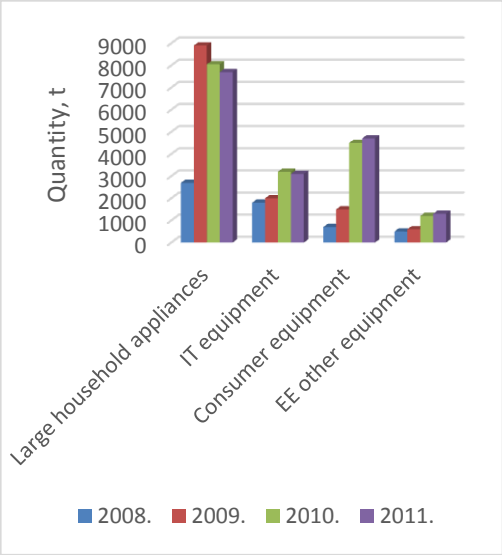

Figure 4. The combined amount of EE waste by type of equipment in the period from 2008 to 2011 [5].

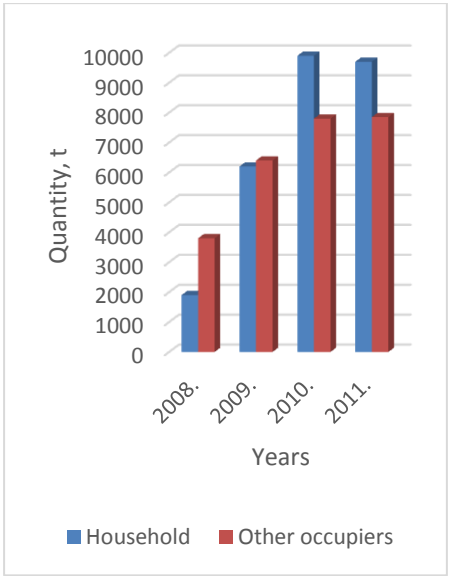

Figure 5. The combined amount of EE waste from households and other landowners in the period from 2008 to 2011 g [5].

4. Conclusion

The Croatian accession to the European Union issued a number of responsibilities, including reporting achievement of objectives in the field of EE waste management.

According to data from the Environmental Protection and Energy Efficiency Fund, in 2011, 3.95 kg / inhabitant EE waste was collected, meaning that the objective of 4 kg/ inhabitant of separate collection was not met.

In the coming period, it is necessary to improve public information and work on raising awareness about the importance of separate collection of EE waste.

It is necessary to improve solid waste management in significant amounts of waste end up and should be collected separately. Still, a significant number of people are not familiar with the possibilities of free disposal of electric and electronic waste.

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BIOLOGICAL PLANT PROTECTION OF INDIAN TOBACCO (*LOBELIA INFLATA* L.)

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Abstract
Lobelia inflata L. is a native North American species that seems to possess various pharmaceutically significant properties. Its main alkaloid is lobeline which, due to its stimulating effect on the respiratory center, is used in case of gas- and narcotic poisoning. In Hungary the seeds were sown in glasshouse. The seedlings were transplanted into the open field. From June to August 2010 we observed significant damages caused by Spanish slug (Arion vulgaris) and Roman snail (Helix pomatia).

Keywords:
Lobelia inflata, plant protection, Arion vulgaris

1. Introduction

Indian tobacco (*Lobelia inflata*) is a native North American species [1]. It is mainly an annual plant [2], but biennial populations can be found, too. Lobelia is named after Flemish Botanist Matthias de L'Obel (1538-1616) [3]. *Lobelia inflata* synthesize important medicinal materials. It is important to protect the plant against various pests. Several snail species damage the plants of the *Campanulaceae* [4, 5]. According to the current taxonomic classification, *L. inflata* belongs to the family of *Campanulaceae* and to the genus of Lobelia [6]. The aim of our studies was the biological plant protection of *L. inflata* in open field conditions.

2. Method

In the course of the open field trials different contained nutrients were applied according to the following methods in 2010: untreated (control), 50 kg/ha Nitrogen-, 100 kg/ha Nitrogen ground fertilizers and 50 kg/ha Mg ground fertilizer. Experimental plants were propagated by seedling and subsequent transplants were grown in glasshouse controlled by a fully automatic energy-umbrella. Seedlings were placed in glasshouse on 15th of January 2010 and were transplanted to multi-cellular transplant raising trays between 1st of May and 5th of May. They were further grown for one and a half month. Mg (2%) - and N (34%) fertilizers were spread onto the soil surface, one day prior to transplanting. Date of transplanting: 15th of June 2010. The number of plants per plot was 27. The measurement of plot was 1.2 m^2. The experimental design was a randomized blocks with 4 repetitions. As a result, several plants had to be substituted. Mechanical weed control was applied. No chemicals or herbicides were applied. Plant height (cm), leaf length and width were measured four times: 8th of July, 17th of July, 24th of July and 1st of August, and fresh biomass (g) on 5-6th August. In each treatment 7 plants were measured. The harvest took place on 5-6th of August, when the biomass was recorded. A significant damage was caused by Spanish slug (*Arion vulgaris*) and Roman snail (*Helix pomatia*). Major problems were observed during plant growth. In 2010 the rainy weather favoured the reproduction of snail species in the experimental area and the number of snails increased. Carakol-6 slug pellet was used against the snails. It contains metaldehyde (6%) as active ingredient and it was applied to the open field area in 0.6 g/m^2 dose. Higher concentrations are moderately hazardous to aquatic organisms. Following the harvest, the plants were dried in a shaded and well-ventilated greenhouse. The dry weight was determined on 30th of August. The flowering phenophase was observed between July and September [7].

3. Results

The results of the experiments show that Carakol-6 slug pellet agent was used successfully in the plant stand. Figure 1 illustrates the *Arion vulgaris* damages of the *Lobelia inflata* plantation. The damage was caused by *Arion vulgaris* (90%) and *Helix pomatia* (10%).
Table 1 shows the daily number of *Arion vulgaris* and *Helix pomatia* on the *L. inflata* plantation from June to August. In July low amount of snails were found in the experimental area. The slug pellet was used on 18th June and the following day 28 snails were found. Until the harvest, (5-6th August) the number of snails decreased.

Figure 1. Damage of Arion vulgaris on Lobelia inflata (2010)

Table 1. The number of Arion vulgaris and Helix pomatia in the Lobelia inflata plantation per day

	2010		
Day	June	July	August
1	-	0	0
2	-	2	2
3	-	n.d.	2
4	-	n.d.	3
5	-	2	0
6	-	0	7
7	-	8	-
8	-	0	-
9	-	0	-
10	-	0	-
11	-	1	-
12	-	0	-
13	-	0	-
14	-	0	-
15	n.d.	0	-
16	n.d.	0	-
17	n.d.	0	-
18	8	0	-
19	**28**	0	-
20	9	0	-
21	4	0	-
22	1	0	-
23	7	0	-
24	2	0	-
25	4	0	-
26	n.d.	1	-
27	1	0	-
28	0	0	-
29	1	0	-
30	1	0	-
31	-	0	-

n.d. = no data (not valuated)

4. Conclusion

Based on the experiments, chemical plant protection was needed against the snail species. These increase the cost of production, but cause better quality and higher quantity of harvested crops. It is necessary to develop new specific agronomic techniques for disregarding the application of pesticides.

Acknowledgement

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THE TOTAL ALKALOID PRODUCTION OF INDIAN TOBACCO (*LOBELIA INFLATA* L.) IN OPEN FIELD CONDITIONS

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Abstract

Lobelia inflata L. is a medicinally important species of the Lobeliaceae family. It is native to North America and contains numerous piperidine alkaloids. The main alkaloid is lobeline that has been used as a respiratory stimulant. The aim of our studies was to follow the total alkaloid production of L. inflata in open field conditions. The highest total alkaloid content of the herb was in the 50 kg/ha Mg treatment (490 mg/100 g). Lobeline content was higher in herb of the 50 kg/ha Mg treatment (445 µg/g). The highest biomass value of the herb was in the 100 kg/ha N treatment (6.7 g).

Keywords:
Lobelia inflata, total alkaloid, biomass

1. Introduction

Indian tobacco (*Lobelia inflata*) is a native North American species [1]. It is mainly an annual plant [2], but biennial populations can be found, too. Lobelia is named after Flemish Botanist Matthias de L'Obel (1538-1616) [3]. The *Lobelia inflata* synthesize important medicinal materials. The herb contains several piperidine skeleton alkaloids [4]. Its main alkaloid is the lobeline that has a stimulating effect on the respiratory centre [5]. Recently, it has been come into light due to a research on CNS, drug abuse and multidrug resistance [6, 7]. To satisfy the market needs, it is important to increase the content values and the biomass of the plant [8, 9], for which a great opportunity arises through the nutrient supply of the plant. The aim of our studies was to compare the total alkaloid and biomass production of *L. inflata* in open field conditions.

2. Method

The open field trials were carried out during 2010-2011. The nutrients were applied in the following methods and quantities in 2010: untreated (control), 50 kg/ha Nitrogen-, 100 kg/ha Nitrogen ground fertilizers and 50 kg/ha Mg ground fertilizer. The nutrients were applied in the following methods and quantities in 2011: untreated (control), 50 kg/ha N-, 100 kg/ha Nitrogen ground fertilizers, 50 kg/ha Mg- and 100 kg/ha Magnesium ground fertilizers. Plants were sown in glasshouse in January 2010 and 2011. Seedlings were transplanted to multicellular transplant raising trays, between the end of April and begin of May. Mg ($MgSO_4$, 2%) - and N (NH_4NO_3, 34%) fertilizers were spread onto the soil surface, one day prior to transplanting (15 June, 2010) with 27 plants per plot. Transplanting was carried out in 26-27 May 2011 with 40 plants per plot. The experimental design was a randomized blocks with 4 repetitions. Mechanical weed control was applied. Plant height (cm) was measured in 2010 four times (8 July, 17 July, 24 July, 1 August) and in 2011 three times (22 July, 29 July, 7 August). In each treatment 7 plants (2010) and 8 plants (2011) were measured. The first harvest took place on 5-6 August 2010, respectively on 9-10 August 2011, when the biomass was measured. Following the harvest, the plants were dried in a shaded and well-ventilated glasshouse. The dry weight determination was 30 August 2010 and 1 September 2011. The flowering phenophase was observed from July to September [10].

Alkaloid extraction

Lobelia inflata (1 g), was dried, powdered, and extracted with 1x20 ml, and 2x10 ml of 0.1 N HCl-methanol (1:1, v/v) by sonication for 3x10 min. After centrifugation and filtration the methanol evaporated and the remaining aqueous phase was made up to a stock solution with 0.1 N HCl. Samples of this solution were purified by solid-phase extraction (SPE). The total alkaloid content was determined by a spectrophotometric method elaborated by Mahmoud and El-Masry [11] and modified by Krajewska [12]. Supelclean LC-8 columns (Supelco Bellefonte, PA, USA) were used for SPE. Aliquots (10 mL) of the stock solution were loaded on to octyl SPE micro-columns previously activated with 5 mL methanol, and 5 mL water. The columns were then washed with 2.5 mL water to remove matrix. After air drying of the cartridge, the alkaloid containing fraction was eluted from the tube with 2x2.5 mL methanol. Instrument: Surveyor (Thermo Finnigan, San Jose, CA, USA) HPLC system consisting of a quaternary gradient pump with an integrated degasser, a PDA detector, and an autosampler. Thermo Finnigan ChromQuest 4.0 software used for data

acquisition, processing, and reporting. Column: Knauer Eurospere 100-C8 (250 mm x 3 mm I.D.; 5 µm), with precolumn (5x3 mm I.D.). Column temperature: 25 °C. Injection volume: 5 µL. Mobile-phase: acetonitrile: 0.1 % trifluoroacetic acid (30:70, v/v). Flow-rate: 0.8 mL 1/min. Analysis was performed in positive ion mode on an Agilent 6410 Triple Quad LC/MS system using electrospray ionization. Alkaloids were separated on a Knauer Eurospher 100-C8 (5 µm) reversed-phase column (250 mm x 3 mm I.D.), with precolumn (5 mm x 3 mm I.D.), with 30:70 (v/v) acetonitrile: 30 mM ammonium format, pH 2.80. The solvent flow rate was 0.8 ml/min and column temperature was set at 25 °C. The injection volume was 10 µL. By solvent splitting, 40 % eluent was allowed to flow into the mass spectrometer. The conditions of the LC-MS/MS analysis were as follows: nebulizer pressure 45.0 psi, drying gas flow rate 9 L 1/min, drying gas temperature 350 °C, capillary voltage 3500 V, scan range from m/z 50 to 700 at collision energy of 15 or 20 eV depending on the molecular structure.

3. Results

References in the literature on the mineral nutrition of *L. inflata* are scarce, although it is one of the basic factors for the successful production of this species. With the goal of introducing *L. inflata* into cultivation in Hungary, our experiments were aimed at clarifying the basic nutrient requirements.

Table 1. Total alkaloid (mg/100g) content of Lobelia inflata herb in open field conditions (2010-2011).

Treatments	2010	2011
Control	450	457
50 kg/ha N	488	362
100 kg/ha N	389	422
50 kg/ha Mg	490	412
100 kg/ha Mg	---	403

Table 1 illustrates the total alkaloid production of plants in the open field experiments. Total alkaloid content (in 2010) of above ground plant parts is 490 mg/100 g (50 kg/ha Mg-treatment), this value is 8.9% higher than the control. Total alkaloid content (in 2011) of *Lobelia inflata* herb is 457 mg/100 g (Control), this value is the highest.

Table 2. Lobeline (µg/g) content of Lobelia inflata herb in open field conditions (2010-2011).

Treatments	2010	2011
Control	234	359
50 kg/ha N	295	409
100 kg/ha N	255	344
50 kg/ha Mg	281	445
100 kg/ha Mg	---	411

Table 2 summarizes the lobeline production of plants in the open field experiments. The lobeline content (in 2010) of above ground plant parts is 295 µg/g (50 kg/ha N-treatment), this value is 26.1% higher than the control. The lobeline content (in 2011) of *Lobelia inflata* herb is 445 µg/g (50 kg/ha Mg-treatment), this value is 24% higher that the control. It could be concluded that in the form of ground fertilization, both nitrogen and magnesium had a favourable effect on the formation of biomass.

Table 3. Biomass (g/plant) production of Lobelia inflata herb in open field conditions (2010-2011).

Treatments	2010	2011
Control	3.51	5.41
50 kg/ha N	5.87	5.48
100 kg/ha N	3.65	6.90
50 kg/ha Mg	4.16	4.13
100 kg/ha Mg	---	6.08

Table 3 illustrates the dry biomass values recorded (in 2010 and in 2011) for above ground plant parts, at the flowering phenophase. In 2010 that was highest in the 50 kg/ha N-treatment (5.87 g) followed by the 50 kg/ha Mg-, 100 kg/ha N-treatments. The lowest values were recorded for the control. The biomass production in 2011 of *Lobelia inflata* herb is 6.9 g (100 kg/ha N-treatment), this value is 27.5% higher that the control.

4. Conclusion

In the field trials of *L. inflata* we have evaluated the favourable effect of fertilization. As a result, in 2010, N- and Mg-fertilization increased the total alkaloid content (mg/100g) of above ground plant parts is 490 mg/100g (50 kg/ha Mg-treatment), while in the 50 kg/ha N-treatment is 488 mg/100g.
The average above ground lobeline content (µg/g) is 295 µg/g (50 kg/ha N-treatment). The 50 kg/ha Mg-treatment value is 281 µg/g. The average above ground dry biomass weight (g/plant) is 5.87 g/plant (50 kg/ha N ground fertilizer treatment). The 50 kg/ha Mg ground fertilizer value is 4.16 g/plant.
The results in 2011 indicate that N- and Mg-fertilization increased the dry biomass production (g/plant) of above ground plant parts is 6.9 g/plant (100 kg/ha N-treatment). The 100 kg/ha Mg ground fertilizer value is 6.08 g/plant. The lobeline content (mg/100g) of above ground plant parts is 445 mg/100g (50 kg/ha Mg-treatment). The value of the 50 kg/ha N-treatment is 409 mg/100g. The total alkaloid content (mg/100g) of *Lobelia inflata* herb is 457 mg/100g (Control), while in the 50 kg/ha Mg-treatment is 412 mg/100g and the 100 kg/ha N-treatment is 422 mg/100g.

Acknowledgement
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COGNISATION AND AGRICULTURAL PRODUCERS OPINION ON NEW LAW REGULATIONS IN THE FIELD OF PLANT PROTECTION IN EASTERN CROATIA

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Abstract
One of the news in Croatian legislation after accession to the European Union is adoption of the Law on sustainable use of pesticides, which entered into force on 5 February 2014. As the legal basis came before his adoption is Directive 2009/128/EC of the European Parliament and the Council in establishing a framework action to achieve the sustainable use of pesticides. The purpose of the above mentioned Law is to reduce the risk of adverse effects of pesticide use, the application of the basic principles of integrated pest management and the promotion of alternative approaches and techniques. The aim of this paper is based on analysis of the survey which was attended by 100 agricultural producers, cognize how much they know and what they think about the new legislation. The results showed that 72% of respondents are aware that by the adoption of the Law on sustainable use of pesticides terminates the Law on Plant product protection, and 78% were informed about the introduction of compulsory education. Also, 84% of respondents believe that the Law adoption is reasonable, but almost the same number, 83% thought that brings additional loads in agricultural production. Opinion of 86% of the respondents is that the law was not sufficiently represented in public and 55% of them considered that the presentation should be understandable. According to the results, it can be concluded that majority of respondents are aware of the changes introduced by the new legislation.

Keywords:
Law on sustainable Use of Pesticides, Rulebook on establishing framework of action to achieve the sustainable use of pesticides, Eastern Croatia, agricultural producers, survey

1. Introduction

Agriculture today is facing a great challenge. On the one hand, the need for food due to the growth of the human population is constantly increasing; on the other hand, there is a limit in terms of surface soil suitable for crop production. In order to achieve maximum productivity were implemented a number of agro-technical measures. One of them is the use of various pesticides with intent to reduce losses caused by harmful organisms and increase the yield, provide better quality of agricultural products and favorable prices of food. However, the "reverse process" is prompted. The resistance of pests associated with pesticides necessitated with their increased use, which also threatened food, soil and drinking water reserves [1]. In addition to the harmful effects of pesticides on the environment, they are evident to human health or even life. According to estimates by the World Health Organization in the 1970s, at the global level was 500 000 cases of pesticide poisoning annually and 5,000 deaths [2]. The figures in 1985 went up to around 3 million cases hospitalized due to poisoning by pesticides and approximately 220,000 deaths [3]. This problem could be solved by cooperation through joint activities of people, national governments, the agrochemical industry, scientists and international agencies in any control program. International agencies, particularly the World Health Organization and the International Labour Organization have significantly contributed to efforts to control pesticide poisoning. It is necessary to continue activities with special emphasis on education and training on safety when using pesticides [2].

The European Union's adoption of Council Directive 91/414/EEC established a single legal framework for the evaluation of active substances and preparations and to assess the risk to human health, animals and the environment. Nevertheless, adverse pesticide residues except as established in the environment in a certain percentage of agricultural products were over the maximum allowable amount. In order to establish a series of legislative measures that should lead to a reduction in risk to the environment, humans and animals, was adopted the Thematic Strategy on the Sustainable Use of Pesticides 2002. Higher level of consumer exposure to pesticide residues via food enabled the Regulation 396/2005 of the European Parliament and the Council was brought 2005. Then, followed the Directive on establishing a framework of action to achieve the sustainable use of pesticides, the Regulation on pesticide

statistics and Directive on the certification of devices for the application of pesticides. Following the review of the Directive on the placing on the market of plant protection products, it has been replaced by Regulation 1107/2009 concerning the placing of plant protection products on the market.
By joining the EU requirements related to plant protection products and their use in the Republic of Croatia have been regulated by the Law on Plant Protection Products. Regulations on maximum residue levels of pesticides in food and feed for plant and animal origin brought by the law in the Republic of Croatia 2008 were taken from the provisions of Regulation 396/2005. Implementation of the Directive 2009/128/EC provisions in the Regulation on the establishment of an action framework for achieving a sustainable use of pesticides has created the legal basis for the adoption of a national action plan [4] and the Act on the sustainable use of pesticides, which entered into force on 5 February, 2014.
The purpose of this legislation is to reduce the risks and negative impacts of pesticide use, the introduction of compulsory application of the basic principles of integrated pest management and of alternative approaches and techniques [5].
The aim of this paper is based on analysis of the survey, in which the farmers from Eastern Croatia realize how much they know and what they think about the new regulations and obligations that are introduced.

2. Material and Methods

Data were collected during May and June, 2014 through a survey intended for agricultural producers. The study included 100 subjects of both sexes, of all ages and levels of education from Eastern Croatia. The questionnaire, in addition to general information about the subject contains 15 closed questions with offered confirmation or negative response. Regulations on establishing a framework of action to achieve the sustainable use of pesticides [6] was used as the basis for drawing up the questions:
1 Do you know that on 5 February, 2014 The Act entered into force on sustainable use of pesticides and thus terminated the Law on Plant Protection Products?
2 Did you know that the above mentioned law proscribes mandatory training for all professional users to acquire and update knowledge on the safe handling and proper application of pesticides?
3 Have you been informed that professional users of pesticides after 26 November, 2015 must possess a card, which is issued on the basis of a certificate of examination?
4 Do you think that by taking this exam it will help you properly protect agricultural crops and to warn you of the dangers of pesticide?
5 Do you know that by purchasing pesticides on each invoice will be quoted card number of the person who sold and those who bought the pesticide?
6 Did you know that all devices for applying pesticides by 26 November, 2016 must be reviewed at least once and have a sign of the inspection checklist?
7 Do you know that professional users will not be able to possess, retain or apply the funds that are not registered in Croatia?
8 Do you know that information on registered plant protection products can be found using an internet search engine at the following address: http://fis.mps.hr/trazilicaszb?
9 Did you know that professional users need to keep and retain records of utilized funds for the plant protection for at least three years?
10 Did you know that by the Regulations on the establishment of an action framework for achieving a sustainable use of pesticides (which preceded the Law on the Sustainable Use of Pesticides) promotes integrated pest management?
11 Do you know what is meant by the Integrated Pest Management?
12 Were the Law on Sustainable Use of pesticides and Regulation on establishing a framework of action to achieve the sustainable use of pesticides sufficiently represented in public?
13 Have the legislation mentioned in the previous question been presented in an understandable way?
14 Law of the sustainable use of pesticides introduces greater control over the sale and use of pesticides, improving the safety of the health of persons who apply pesticides and people who consume the produced food and environmental benefit. Do you think its establishment justified?
15 Do you believe that the adoption of the above mentioned Law further strain on agricultural production by introducing new financial commitments and expenditures?

3. Results and discussion

Results of the analysis of the survey (Figure 1) showed that the majority of participants (56%) are in the age group 25-55 years of age. In the group of up to 25 years is 28%, whereas in the group with more than 55 years is the lowest number (16 %).

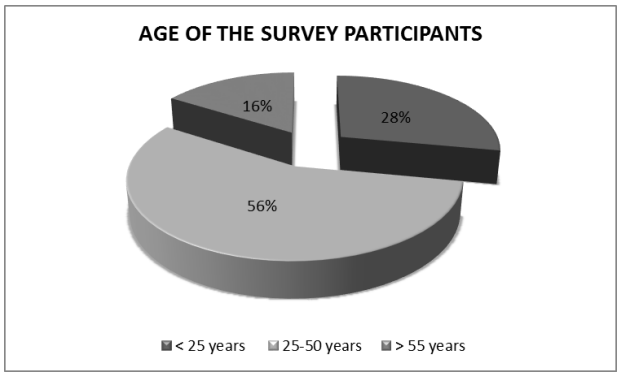


Figure 1 Graphic of the age of the survey participants

The study included more males (63%) compared to the female sex (37%) (Figure 2).

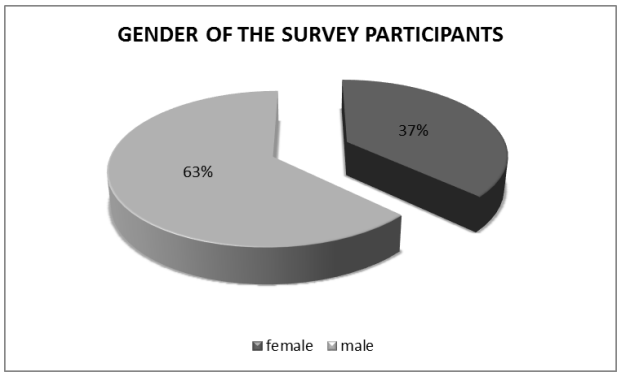
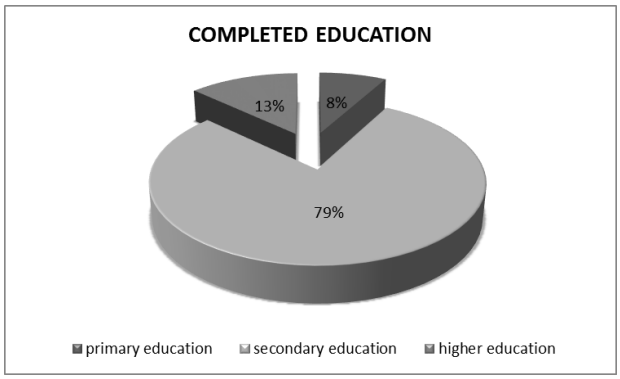


Figure 2 Graphic representations of the participants with regard to gender

Given the level of education completed, most of them are with secondary (79%), followed by higher education (13%), and with least primary education (8%) as shown in Figure 3 graphs.



Figures 3 Graphical presentation of completed education of participants

On the question of education in the field of agriculture, agricultural high school finished 34%, higher or university degree 12% of the participants, and the educational course 8%. Surprising, but also disconcerting fact is that the majority (46%) do not have any education in the field of agriculture (Figure 4).

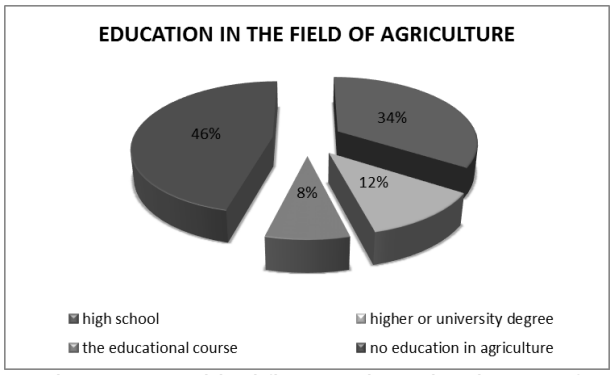


Figure 4 Graphical figures show the degree of educational level of participants in agriculture.

The participants were asked to circle one or more of these groups of crops on which pesticides are applied: field crops, fruit trees, vines, vegetables, ornamental plants. The results shown in the chart in Figure 5 showed that respondents most often treated fruit (58%), field crops (50%), vegetables (42%), less vines (33%), and least ornamental plants (23%). Among the producers who use pesticides on agricultural crops there are most of those (40%) that do not apply it to other plant species. Of the total number of participants who treated fruit, 14% do not apply pesticides except in fruit, 21% makes it to the vine and less on other cultures. Vegetable producers usually have rounded up more choices, only 14% of pesticides used solely to herbal products. Similarly, in ornamental plants, participants treat with pesticides different cultures, and 22% of it is only ornamental plants.

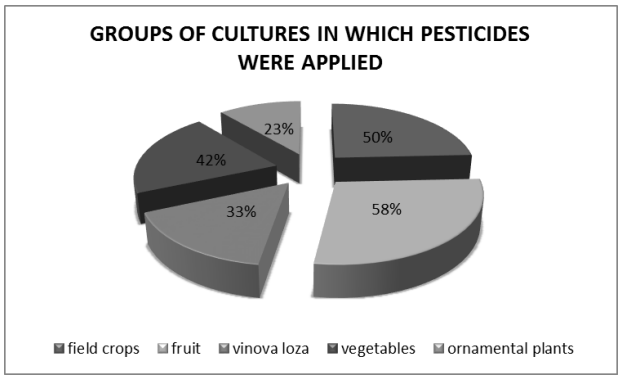


Figure 5 Graph showing groups of cultures in which participants apply pesticides

The first question most manufacturers (72%) responded positively to the request if they know that on 5 February, 2014 The Law entered into force on sustainable use of pesticides, by which ceased to be valid Law on Plant Protection Products.

Until the adoption of the above mentioned Law, in Croatia training system was not comprised of professional pesticide users, distributors and advisers, but it was done based on the program of the course of plant protection training for

employees to work in agricultural pharmacies. On the question if they know that the new Law provides mandatory training for all professional users answered affirmatively, 78%.
The new training system for professional users and advisors consists of a basic module for a minimum of 15 teaching hours and additional modules of at least 5 hours. Most respondents (72%) are familiar with the obligation of owning a card after 26 November, 2015 which will be issued on the basis of a certificate of examination.
For the next question, by confirmation of 71% respondents considered that their passing this exam will help in the proper protection of agricultural crops and warn them of the dangers of pesticide application.
When buying pesticides on each account will be, after this date, specify card number of the person who sold and those who bought the pesticide which is informed 66% of users while 34% responded negatively.
In the Republic of Croatia devices for applying pesticides are evaluated on a voluntary basis and at the request of commercial standards. The system of mandatory periodic review is established by the Ordinance establishing a framework of action to achieve the sustainable use of pesticides, and will be conducted by authorized testing stations. The producers were asked if they knew that all the devices for the application of pesticides on 26 November, 2016 must be reviewed at least once and have a sign on the performed examination. Therefore, on this question confirmedly answered 45% versus a higher percentage of producers (55%) who are not familiar with this obligation.
The training of professional users as one of the areas includes the existence and risks of illegal pesticides and methods for recognizing these products. Among the people surveyed, 62% know that professional users will not possess, retain or apply the funds that are not registered in the Republic of Croatia.
Furthermore, a small number (only 28%) knows that the information on registered plant protection products can be found using Internet search engines at: http://fis.mps.hr/trazilicaszb.
The Regulations establishing a framework of action to achieve the sustainable use of pesticides requires that professional users in the records of plant protection products enter the trade name of a plant protection product, date and time of commencement and completion of treatment, the amount of product applied, the size of the area treated and culture, object, surface or other use. Analysis of the answers to ninth questions found that 60% of respondents are aware of the obligation of keeping these records for at least three years.
Furthermore, the Regulations expect that the professional users will through incentives encourage the voluntary implementation of technological instructions for integrated production. In this way, the agricultural production will introduce a series of measures for the implementation of plant protection with reduced use of pesticides giving priority to non-chemical methods, which is informed 49% of participants.
Participants were asked if they know what is meant by the Integrated Pest Management in which 66% responded in the affirmative and negative 34%.
Opinion that the Law on Sustainable Use of Pesticides and Regulation on establishing a framework of action to achieve the sustainable use of pesticides were sufficiently represented in the public shares only 14%, and that they are not presented in an understandable way believes 55% of participants.
Only 16% of respondents believe that the adoption of a new law was needed. Even 84% of the manufacturer's support greater control of the sale and use of pesticides, which is introduced and thus gives greater safety to the health of persons who apply pesticides, and consumers of the produced food and the environment.
However, 83% of users of pesticides believe that by adoption of the Law on sustainable use of pesticides along with all the positive aspects, burden the agricultural production due to the introduction of new financial obligations and expenditures.

4. Conclusions

The results of the survey show that a large number of farmers (over 70%) are familiar with the entry into force the Law on the sustainable use of pesticides and all obligations it introduces. By analyzing the responses, it was revealed a high level of awareness (over 80%) of the need for greater control of the sale and application of pesticides and thus the justification of changes in legislation. The participants in the new Law recognized the possibility that through the training they could gain additional knowledge about the proper protection of crops and increase safety for themselves as users of pesticides, consumers produced food and the environment. The lowest level of awareness (28%), participants showed regarding the ad on the web browser through which they can get information on all registered plant protection pesticides. The above mentioned number will eventually increase because of obligatory monitoring for information on a search engine. It should be taken into account that according to previous regulations pesticide users did not have to attend any additional training, and a large number of those surveyed have no education, meaning basic knowledge of agriculture. Furthermore, less than half of the

participants are aware of the obligation to review the device for the application of pesticides as well as that by the new Law it will be encouraged to integrate pest management which is in accordance with the opinion of the respondents that the new regulations should be presented in a more understandable way. Despite the generally positive attitude of participants to the provisions introduced by the Law on the sustainable use of pesticides, participants expressed the opinion that this is additional financial burden for agricultural producers.

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SOIL MOISTURE MONITORING BETWEEN THE DANUBE AND THE TISZA RIVER

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Abstract

The theoretical and practical scientific researches support the theory, that human activities change the climate. A part of the changes refers to the averages, for example the increase of the temperature, or like in our country refers to the long-term decrease of the precipitation. It concerns particularly such countries and regions where the temporal and spatial variability of the precipitation is high [9]. These facts are especially apply between the Danube and the Tisza river where the extreme situations are typical. The study examines the complex water balance of my sample points especially the relationship between the soil, the soil moisture, the groundwater, the precipitation, the temperature and the evaporation, but in this research deals only with a little part of it.

Keywords:

soil moisture, water balance, groundwater, precipitation, evaporation

1. Introduction

This research is an introductory stage of a large-scale research started in 2012 dealing with the complex examination of the water balance of six sample points which is located on one of the driest regions in Hungary. The soil, the base-rocks, the ground water, the humidity of the soil, the precipitation, the temperature and the evaporation has been monitored and the relation between them has been examined in this large-scale project.

The observed area is located in the central part of Hungary in the region called “Duna-Tisza köze” (Figure 1). The main part is located in the “Kiskunsági-homokhát”, but some parts expand to neighbouring small regions (e.g. “Csepeli-sík”, “Solti-sík”, “Bugaci-homokhát”) [1].

The table-land part of the area is made up of wind transported sediments, shifting sand and loess (yellow soil) and it is a little undulatory. There are saline lakes, peaty, mull soils and swamps in the negative forms between the shifting sand hills and loess deposits. The smaller, northern part of the area located in the Danube watercourse is made up of fluvial (pebble, sand, clay) and fluvio-eolic sediments (sand) which are salinized on the surface in many places [4] [5].

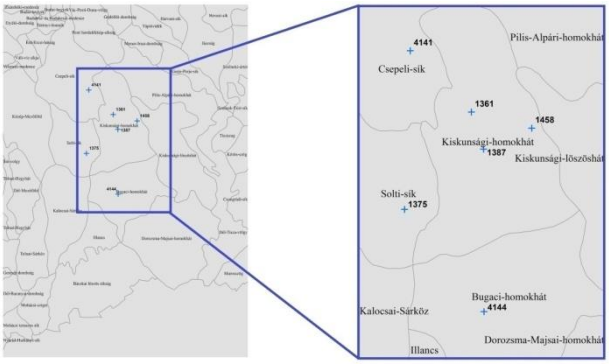

Figure 1. The location of the examined sample points

The climate of the area is moderate continental and heavily altering throughout the year. Its special characteristics are the moderate overcast, the high amount of sunny hours, and the high daily and yearly alteration of temperature, the relatively high drought and the low percentage of air moisture. The annual middle temperature is 10-11 C°. The „Kiskunsági-homokhát” is one of the driest part of Hungary, the annual sum of precipitation is 520-540 mm, the average precipitation in Hungary is 500-750 mm. The characteristic of the precipitation of the area is unfavourable concerning the data describing temperature, wind and soil [8].

The area is explicitly dry; it lacks watercourses and almost any kind of water. There were many natural lakes on the table-land but almost all of them are only geologic remnants today because there is no water in them anymore. The hydrogeological character of the area is anthropogenic.

In terms of the topic this area is very interesting because water shortage occurs on this area mostly. The phenomenon is not new, dry periods appeared in previous decades, but in the middle of 80s bigger water shortage emerged more than ever. The reason is very controversial but the harsh weather conditions and different human interventions did not contribute to the positive water balance (e.g. afforestation, water regulation, extraction of groundwater) [6].

2. Materials and methods

The observation of the water balance of the area is a complex task because it is influenced by a number of different factors. These factors are connected to geology, soil, climate, ground water

characteristics and different anthropogenic impacts.
Soil moisture measurements started with near six carefully chosen groundwater wells in the summer of 2012. The main goal was to compare the measured soil moisture data with the movements of groundwater of the examined area.
The wells were chosen according to the near-surface 10 meters of base rocks and the land uses near the wells. Soil samples were taken next to the wells from 1.4 meter deep test holes. The samples are being analyzed in laboratory.
The soil moisture measurements were done by the so-called BR-150 FD based moisture measurer instrument (capacitive soil moisture measuring). The electromagnetic field changes its phase angle depending on the dielectric constant of the soil. So the phase angle change is in relation with the dielectric constant of the soil (permittivity). Because of the fact that the permittivity of the soil is defined by the dielectric constant of water, the capacitive moisture measurer instrument can be calibrated with this data (Figure 2) [7].
There are three 1.3-1.4 meter deep test holes next to each of the six chosen wells (Figure 3). Soil moisture data was measured from every 10 cm segment in every hole with a frequency of one or two weeks.
The research area system has been constantly monitored. Precipitation data is collected from 10 measuring stations, 7 stations provide temperature data, 3 stations provide evaporation data and the ground water is being monitored daily from the ground water wells.

Figure 2. The digital display of the instrument

Figure 3. Three test holes next to a groundwater well

3. Results and discussion

Results discussed in this research are from one of the six wells. We are analyzing the ground water data collected from the well No. 1375, the soil moisture data measured next to the well, the precipitation (“Soltszentimre”) data and the relation between them.

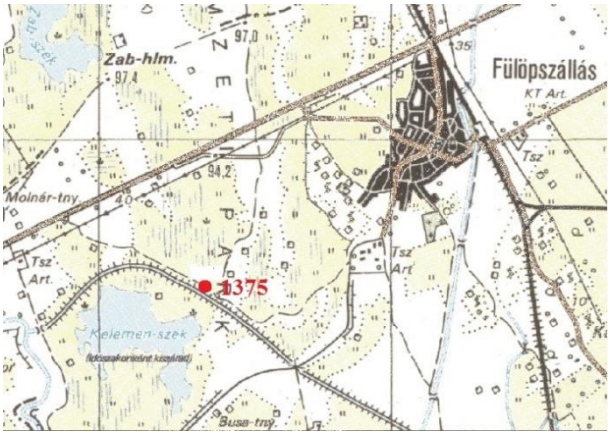

Figure 4. The location of the groundwater well No. 1375

The well is located in the watercourse of the Danube northeast from the “Kelemen-szék” and south from “Fehér-szék” (Figure 4). Saline turf is typical for its surroundings which can be covered with water periodically. Three segments were separated during the collection of the soil samples. The first segment is 70 centimetres deep below the surface with mouldy, dark coloured small fractured sand. The second segment is 1 metre from the

surface, light grey small fractured sand, and the third segment is yellowish grey small fractured sand and quite wet. The typical soil type is sodic soils and humic sandy soils can be found in the area also.
The groundwater well was intstalled in 1930, since then the measurement of the groundwater is continous with smaller interruptions. During this time the groundwater level is characterized by increase, because the well is situated in the valley of the Danube (Figure 5).

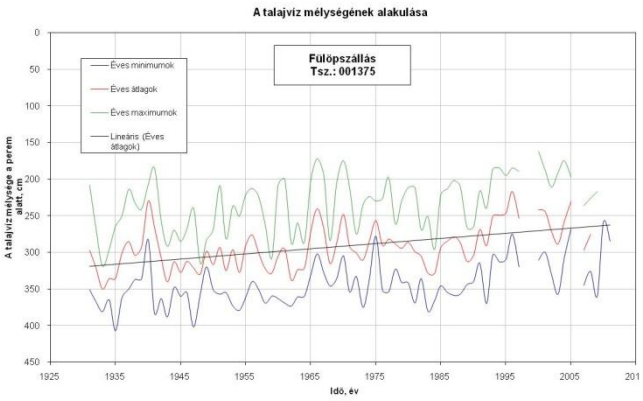

Figure 5. The change of groundwater level of the grondwater well No. 1375 from 1930

The level of ground water is defined by hydrological factors such as the amount of precipitation (annual and long-term distribution), the extents of infiltration and evaporation, and soil and topographical characteristics.
The minimum of the graph is in October-November, when the hydrological summer term is over and the maximum is in April, when the hydrological winter term is over [2]. On Figure 6. both the minimums of October and November and the maximums near April can be observed. The level of ground water altered between 44 and 215 centimetres below surface between the years of 2010 and 2012, this can be followed on the colours of the soil samples. The year 2010 was rich in precipitation, but in 2012 there was a really dry, droughty year (Figure 7.). The shallower the level of the groundwater is, the climate affects the soil more.
During the soil moisture measurements (Figure 8.) the average level of ground water was between 179 centimetres and 218 centimetres. The depth of the three test holes was 130-140 centimetres, so the question was the following: until what depth can we follow the domination of precipitation and evaporation and from what depth can we track the effect of the ground water? The border can be drawn at a depth of 110 centimetres, because we can observe that the graphs start to rise or do not change in this depth probably because of the capillary water movements. Over 110 centimetres the main factors affecting the soil moisture are precipitation and evaporation. The proof of this is the measurement done on 28th September. During the night 4.3 mm of precipitation occurred after a very dry period. The graph shows that the soil moisture increases over 20 volume% between the depth of 10 and 20 centimetres.

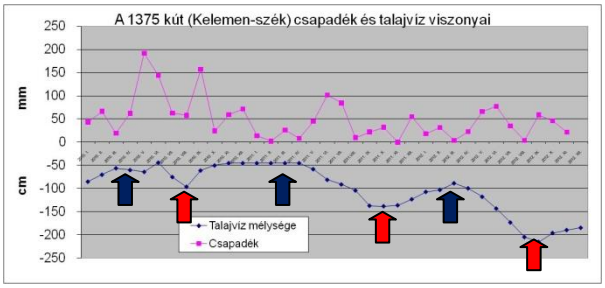

Figure 6. Groundwater level and precipitation conditions of the groundwater well No. 1375 (2010-2012)

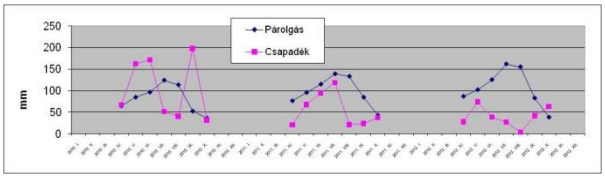

Figure 7. Evaporation and precipitation conditions (2010-2012)

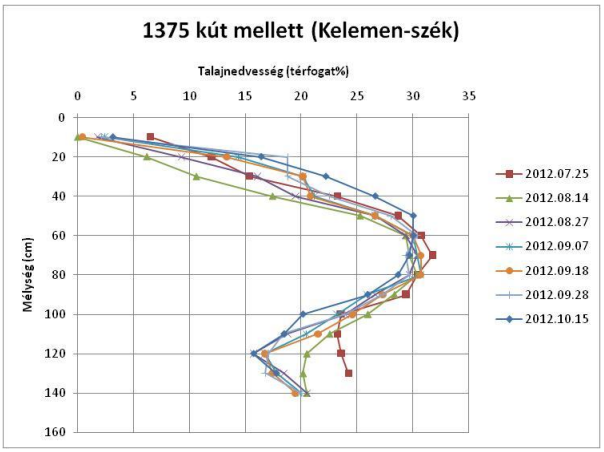

Figure 8. The change of soilmoisture next to the groundwater well No. 1375

4. Conclusion

Overall it can be stated that soil moisture is affected by climate factors, the type of surface and near-surface sediments and the movement of the level of groundwater. But more measurements are needed to be done on areas with different geological and soil characteristics to define the significance of these factors. During the evaluation of the results we highly concentrate on analysing the effect of climate factors and the alteration of ground water level to the soil moisture depending on depth and time.
The Bossel model provides help in the additional processing of the measurement data. The primary

goal of the model application is to study and understand the soil-plant-climate system. The model simulates the procedure of plant biomass-increase according to the soil water and nitrogen content, the land use, and the environmental effects. The model application provides estimation results for scenarios of extreme weather conditions.

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THE STUDY OF THE VIGOR OF THE ROOTSTOCKS – PLUM VARIETY COMBINATIONS

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Abstract

Study was conducted the vigour of the combinations of 6 rootstocks ('Mirobalan', 'St Julien A', 'St Julien GF655/2', 'Fereley', 'Wangenheim', 'Wawit') and 6 plum varieties ('Čačanska lepotica', 'Katinka', 'Jojo', 'Topper', 'Topfive', 'Toptaste'). We planted 18 combinations in 60 cm - deep-containers, which were sunk in the soil, as it was to be carried out an irrigation study as well. The monitoring was in Mid-Hungary in Kecskemét, in the showgarden of the horticulture department of the Kecskemét College, where there is sandy soil and 2 sorts of irrigation were applied. In treatment 1 were given 2 litres of water every hour and in treatment 2 trees were given 4 litres of water at the same time. I measured the trunk diameter and counted the trunk cross area. It was measured the spread and the height of the head of the trees, from which I could count the cubic capacity. The Topfive's vigour was the smallest, and that of the Katinka's was the largest.

Keywords:

plum rootstocks, plum varieties, vigour, irrigation, trunk cross section area

1. Introduction

In case of the stone fruits, the plum, you need to study certain rootstock- variety combinations as their vigor can be quite different. The plum varieties behave differently on different rootstocks, this has already been backed by studies and our monitoring backs it as well.

The plum variety – rootstock combination examinations in Hungary are needed, because the plum rootstocks usage IS rather one-sided, 99 % OF the fruit trees nurseries use myrobalan (*Prunus ceresifera*) seedlings from Cegléd. So the Hungarian plum producers and nurseries need to get informed about St Julien (*Prunus instititia*) and plum (*Prunus domestica*) rootstocks too. 2. Survey of other studies

According to Mr Hrotkó [1] the usage of plum rootstocks is rather one-sided. You can get plum varieties exclusively on Myrobalan seedlings from nurseries in Hungary. The reason for this is that the Hungarian plum producers use traditional technology and the producers' aim is the industrial application so they carry out the harvests with machines and they need strong, heavy-duty plum variety-rootstocks combination for this. But the intensive production and fresh consumption is beginning to spread. We need weaker but productive plum variety-rootstock combinations for the intensive technology.

According to Mr Hrotkó and Mr Magyar the plum is "rootstock dependent this means that certain rootstock-variety combinations' vigor can differ depending on the vigor of the same rootstock but different varieties. In this way in the case of so called weak rootstock, it is not sure that every plum variety results in weak vigor combinations.

3. Material and methods

18 plum variety and rootstock combinations were planted in containers in April 2010. The containers were 60 cm deep with 60 cm diameter, these containers were sunk into the soil. The irrigation was installed successfully in the spring of 2012 so its result could be seen in the data of the spring of 2013.

The varieties studied were: 'Čačanska lepotica', 'Katinka', 'Jojo', 'Topper', 'Topfive', 'Toptaste'; and rootstocks: 'Mirobalan', 'St Julien A', 'St Julien GF655/2', 'Fereley', 'Wangenheim', 'Wawit'.

Table 1. Applied rootstock – variety combinations.

	'Mirobalan'	'St Julien GF655/2'	'St Julien A'	'Fereley'	'Wangen-heim'	'Wavit'
'Topper'	X	X		X		
'Čačanska lepotica'	X		X			
'Jojo'	X		X			
'Katinka'	X		X			
'Topfive '	X	X		X		X
'Toptaste'	X	X	X	X	X	

Every combination was represented by 12 trees, but due to the 2 types of irrigation one combination and one kind irrigation was represented in 6 repetition.

We used 2-kinds of irrigation. The single irrigation means 2 l/h watering and the double irrigation means 4 l/h watering at the same time. The watering sequence lasted 1,5 - 2 hours / occasion. The frequency of the occasions depended on weather conditions and soil water content. We used the dropping irrigation system.

Since the spring of 2010 we have measured trunk diameters at 70 cm height every April. It was counted the trunk cross section area (TCSA cm^2)

from the diameter. You can reason out the vigor of the trees growth from TCSA.
In addition, it was measured the canopy diameter and height, so I could count canopy cubic capacity from these data.

4. Results

In the beginning the 'Topper' and the 'Toptaste' varieties had quite thick trunks (*Figure 1*) , the 'Topper' 2 combinations have developed thick trunks in 2014 too, but the 'Topper'/'Fereley' combinations showed week vigor, this can result IN incompatibility, as 2 trees died in the orchard.
In the beginning the ''Čačanska lepotica', 'Jojo', 'Katinka' varieties on the Myrobalan rootstock had thin trunks, but these trees have developed quite thick trunks. In the case of the 'Katinka' and 'Jojo' varieties sudden thickening could be seen in 2013 and 2014.
The 'Topfive' /'Wavit' combination showed weak vigor all the time.
there are no extreme readings in the diagram at the 'Topfive' /' Fereley' combination, but probably there are incompatibility problems there as well, as two trees survived from 6 trees in 2014.
In the beginning the 'Toptaste' varieties had thick trunks but their thickening decreased gradually.

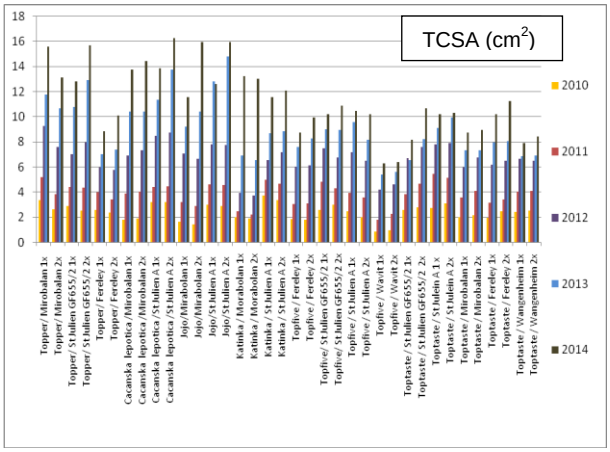

Figure 1. Set of the plum variety-rootstock combinations trunk cross sections area (cm^2) 2010-2014

It can be followed up the development of the canopy of the trees in *figure 2*. As it was measured the size of the canopy of the trees in early spring, before cutting these data show the growth of the trees from the previous year. The data of the spring of 2012 reflects the vegetation term in 2011. So according to the data of 2013, which shows the vegetation term in 2012 the trees developed most vigorously then, mainly you can see these results in the case of the ''Čačanska lepotica' combinations. Based on the data of 2014, that is the vegetation term in 2013, the 'Jojo', 'Katinka' varieties and 'Toptaste'/'Fereley' combinations were standing out in their amount of growth.

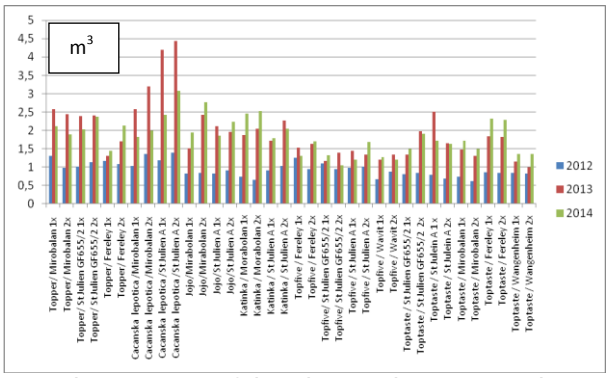

Figure 2. Set of the plum variety-rootstock combinations canopy cubic capacity (cm^3) before cutting 2012-2014

It was counted 2- 4,5m^3 canopy cubic capacity before cutting (*Figure 3*.). Capacity was reduced their capacity rather dastricly for it were had to keep them in space, so the cubic capacity of the trees became 1-2 m^3 after cutting. The ''Čačanska lepotica'/'St Julien A' – with double irrigation had the largest canopy (~1,9 m^3) after cutting too. The two combinations ('Mirobalan', 'St Julien GF655/2') of the 'Topper' had big (1,2-1,4 m^3) canopy volume and the 'Toptaste' combinations were big too, except for the 'Toptaste' /'Wangenheim' combinations. The 'Topfive' combinations developed small canopy volumes (0,8-1 m^3)

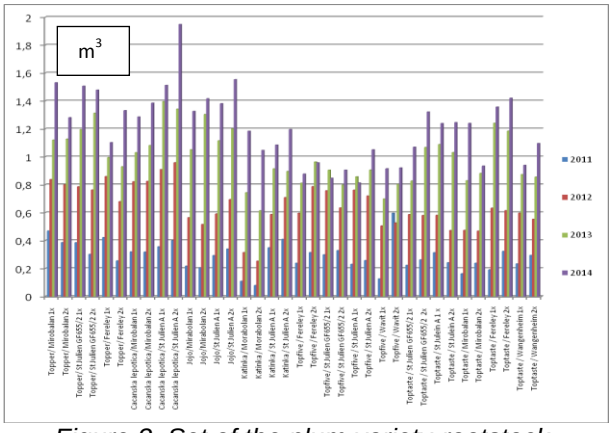

Figure 3. Set of the plum variety-rootstock combinations canopy cubic capacity (cm^3) after cutting 2011-2014

5. Conclusion

The 'Katinka' became fruit-bearing in 2014, so far this variety has developed their parts of the vegetation, mainly these trees grew in 2013 and 2014. However in the beginning 'Toptaste' combinations had thick trunks, after it after early (2012) when they became bearing fruit the big yield resulted in minor tree trunk development. So the time of the tree bearing fruit influences the vigor. As long as the tree does not bear fruit, its growing is strong, but after it the growing of the trees stop. The 'Topfive' combinations develop very weakly on every rootstock. This variety is not fool-blooded enough.

Acknowledgement
This study is funded by TECH_08-A3/2-2008-0373, OM 00264/2008, OM 00272/2008

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THE STUDY OF THE YIELD OF THE ROOTSTOCK AND PLUM VARIETY COMBINATIONS

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Abstract

In my study I examined the vigour of the combinations of 6 rootstocks (Mirobalan, St Julien A, St Julien GF655/2, Fereley, Wangenheim, Wawit) and 6 plum varieties (Cacanska lepotica, Katinka, Jojo, Topper, Topfive, Toptaste). We planted 18 combinations in 60cm -deep-containers, which were sunk in the soil, as I was to carry out an irrigation study as well. The monitoring was in Mid-Hungary in Kecskemét, in the Showgarden of the horticulture department of the Kecskemét College (of the Horticulture Department), where there is sandy soil and 2 sorts of irrigation were applied. Certain trees were given 2 litres of water every hour and others were given 4 litres of water at the same time. I measured the volume of the yield per tree and the amount of fallen fruits too. The results of the study can be read in this article.

Keywords:
plum varieties, rootstocks, yield, irrigation trunk cross section area,

1. Introduction

In my study I would like to show you the setting of the yield of the different plum rootstock-variety combinations. In addition I wish to call the attention of the producers to the fact, that the Myrobalan seedling, which has proven to be productive in Hungary, does not always provide an exclusive solution for productivity in case of our trees. The fruit tree- nurseries should get to know different rootstocks and these rootstocks should be propagated and available in the nurseries in Hungary.

In Hungary, plum is consumed in moderate quantity, the producers would rather produce the plum for the industry. This is the reason, why the traditional farming system with machine harvest is widespread, and this farming system prefers Myrobalan seedlings rootstocks.

In my opinion, the intensive farming system could be introduced, which is characterized by spindle canopy, medium or weaker vigor rootstocks, and productivity varieties, with irrigation system. In addition the harvests are to be carried out by hand too.

In this orchard you can produce fresh plum for immediate consumption, and for export market and you can keep up a profitable orchard.

2. Survey of other studies

The increase of the intensity means early and more yields and the bearing surface is low, which has a number of advantages [1], in contrast with the traditional farming system. The first advantage is its easy cutting, secondly its more effective pest control, and last but not least you can carry out harvesting with hand, on foot on the field. According to Soltész [3] the advantage of intensity is the ability to turn the tree fruitbearing as soon as possible , creating large productivity bearing surface performance at an early stage, keeping up a steady yielding performance, in addition saving the bearing surface during harvesting. [3]

You can create an intensive orchard, using good cropper, super fruit quality varieties [3], these kinds are the 'Čačanska lepotica', 'Stanley', 'Bluefre', 'President', 'Jojo', 'Katinka', and German 'Top…' varieties in the plum variety of the supply [2].

3. The combinations and methods

In my study I examined the vigour of the combinations of 6 rootstocks ('Mirobalan', 'St Julien A', 'St Julien GF655/2', 'Fereley', 'Wangenheim', 'Wawit') and 6 plum varieties ('Čačanska lepotica', 'Katinka', 'Jojo', 'Topper', 'Topfive', 'Toptaste').

Table 1. Applied rootstock – variety combinations.

	'Mirobalan'	'St Julien GF655/2'	'St Julien A'	'Fereley'	'Wangen-heim'	'Wavit'
'Topper'	X	X		X		
'Čačanska lepotica'	X		X			
'Jojo'	X		X			
'Katinka'	X		X			
'Topfive '	X	X		X		X
'Toptaste'	X	X	X	X	X	

I measured the trees trunk diameter, canopy parameters, the yield per trees. I counted mean yield per trees, and specific yield per trees (g/ cm^2) from these data. The specific yield per trees is

projected trunkcross section areas (TCSA). My study not only involved the analysis of the different rootstock and variety combinations, but I used 2-kinds of irrigation too. During the irrigation we used 2-kinds of irrigation. The single irrigation means 2 l/h watering and the double irrigation means 4 l/h watering at the same time. The watering sequence lasted 1,5-2 hours / occasion. The frequency of the occasions depended on weather conditions and soil water content. We used the dropping irrigation system.

The summer of the 2014 was rather rainy, so there no need for irrigation in the summer, due to this we could not observe the effect of the irrigation in 2014.

The following rainfall patterns occured in 2014: in May 60-70 mm; in June 25-35 mm; and July 150 mm.

4. Results

My results show, that there are varieties, which had already cropped in 2011 (after their planting). These are 'Čačanska lepotica' and 'Topfive'/'Wavit' combinations.

In 2012 the 'Topper'/'Mirobalan'; and the 'Topper'/'St Julien GF655/2'combinations cropped about 4 kgs yield per tree. The 'Toptaste'combinations cropped 2 kgs. The other combinations did not yield at all or only showed insignificant amount of yield. The 'Katinka'/'Mirobalan' is going to bear fruit late, in 2014 , but the harvesting time is at the beginning of September , so I can't show these data in this study. You can observe in case of the majority of the combinations that yields were more in 2013, than in 2014. The reason for this was that May was rather cold (15-16°C), the temperature fluctuated between 10-22°C and for this effect the fruit setting fell in a large measure. The 'Toptaste' combinations have performed well in 2014 too, even though the crops fell significantly in case of this variety too.

In 2013 the 'Topper' /'Mirobalan', 'Topper' / 'St Julien GF655/2', A 'Jojo'/'St Julien A', and the 'Čačanska lepotica' combinations crop a considerable amount of yield (12-14 kg). In 2014 'Jojo' /'St Julien A', 'Topper'/'Mirobalan', 'Topper' /'St Julien GF655/2' and the 'Toptaste' /'Fereley' combinations were productive (8-14 kg).

In all the years the 'Topfive' combinations, the 'Toptaste' /'Mirobalan', and the 'Toptaste' /'Wangenheim' combinations bore fruit weakly.

Table 1. The mean yield per trees (g)

nemes/ alany; öntözés	Fánkénti átlagos terméshozamok (g) 2011	2012	2013	2014
Topper/ Mirobalan 1x	0	5192	14052,83	8143,833
Topper/ Mirobalan 2x	0	4584,5	12728,67	9839,333
Topper/ St Julien GF655/2 1x	0	3836,8	11826,67	11597,17
Topper/ St Julien GF655/2 2x	0	4542	15040	11955,67
Topper/ Fereley 1x	0	1060	6696,5	4460,833
Topper/ Fereley 2x	0	1575	6216,667	10160
Cacanska lepotica /Mirobalan 1x	295,02	4468	9276	7085,167
Cacanska lepotica /Mirobalan 2x	295,02	1173,7	9165,167	8101,667
Cacanska lepotica /St Julien A 1x	169	1216,5	11990,33	8396,833
Cacanska lepotica /St Julien A 2x	169	1130	10985	10300,33
Jojo/Mirabolan 1x	0	1892,3	7773,333	5682,667
Jojo/Mirabolan 2x	0	1590,5	3570,167	12628
Jojo/St Julien A 1x	0	1005,4	11815	11739,67
Jojo/St Julien A 2x	0	798,4	12560,33	14141,33
Katinka / Morabolan 1x	0	148,6	286	
Katinka / Morabolan 2x	0	185,5	335,5	
Katinka / St Julien A 1x	0	230,7	3733	6225,833
Katinka / St Julien A 2x	0	901	1874,833	6773,333
Topfive / Fereley 1x	0	226	5837,833	5119,5
Topfive / Fereley 2x	0	348,6	3666,25	5278
Topfive/ St Julien GF655/2 1x	0	365,5	6482,667	3963
Topfive/ St Julien GF655/2 2x	0	751	5801,6	2705,667
Topfive / St Julien A 1x	0	255	6823,333	3860,5
Topfive / St Julien A 2x	0	297,7	7071,667	5783,667
Topfive / Wavit 1x	303	1369,8	3107	2369,75
Topfive / Wavit 2x	303	446,4	2751	1627,333
Toptaste / St Julien GF655/2 1x		2588,8	4163,667	4647,667
Toptaste / St Julien GF655/2 2x	0	2541	4286,6	8114,667
Toptaste / St Julein A 1 x	0	2380	9346,667	7571,833
Toptaste / St Julein A 2x	0	2736,2	5562,5	6696,2
Toptaste / Mirobalan 1x	0	773,3	4225	4625,667
Toptaste / Mirobalan 2x	0	1636	2831,667	4724,5
Toptaste / Fereley 1x	0	1989,5	4892,167	9219,167
Toptaste / Fereley 2x	0	2536,5	5645	12757
Toptaste / Wangenheim 1x	0	1511,6	3513,5	3311
Toptaste / Wangenheim 2x	0	828,4	2777,5	4444,4

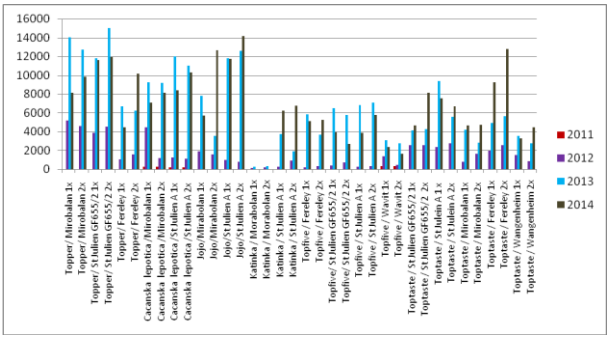

Figure 1. The mean yield per trees (g)

The specific yield per tree shows how much a certain combination is vegetative or generative, as I divide the mean yield per trees with the TCSA and in this way I learnt how much yield there is to 1 cm^2 TCSA. In 2012 the 'Topper' / 'Mirobalan' and the 'Topper'/'St Julien GF655/2' specific yield per tree were significant (580-600 g/ cm^2). In 2013 also these combinations were outstandingly performing having great yield (1100-1200 g/cm^2). But in 2014 these two combinations performed weakly. Instead of these, the 'Toptaste'/'Fereley' combination was outstanding with 900-1100 g/ cm^2. You can see high performance results (~900 g/cm^2) from the figure 2 in case of the 'Jojo' / 'St Julien A' combination too. While you can conclude from the high value to generative prevalence, from the low value to vegetative prevalence, in one word the system of the tree developed more vigorously, than the yield.

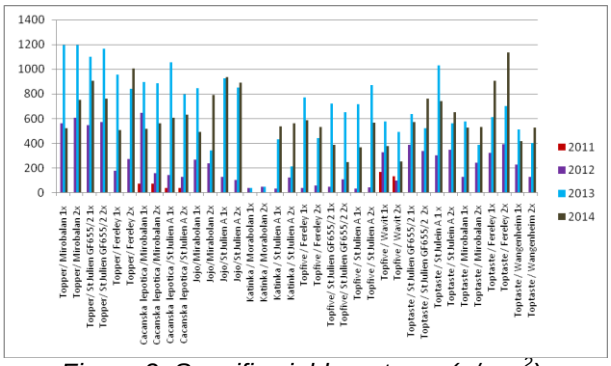

Figure 2. Specific yield per trees (g/ cm^2)

5. Conclusion

The earliest fruitbearing combinations are: 'Čačanska lepotica' combinations, 'Topfive'/ 'Wavit'. There are late fruitbearing combinations: 'Katinka' /'Mirobalan'. Productive combinations are: 'Topper' /'Mirobalan'; 'Topper'/ 'St Julien GF655/2', 'Jojo'/'St Julien A', and the 'Toptaste' /'Fereley', but the 'Topper'/Fereley' does not crop a lot of yield. So it is important to know, how much plum you can produce depending on the plum varieties on different rootstocks. Certain rootstocks, which are good in case of certain varieties may show weaker productivity with the other varieties. Or perhaps incompatibility may arise, which I could observe with 'Topper' /'Fereley' and 'Toptaste' /' Wangenheim' combinations. The incompatibility can manifest showing too weak growth, yellowing foliage, poor productivity, or leaves falling earlier than usual.

Acknowledgement

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REDUCTION OF DON-TOXIN CONTENT IN WHEAT

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Abstract
Across the whole food chain – from the production of raw material to processing and sale of final product - the adequate technical background is important factor to fulfil the food safety criterias determined by laws and market requirements. Therefore it is essential that the suppliers can deliver machinery and equipments which must correspond to the food safety requirements and these conditions can be guaranteed for a long time.
Adequate technical conditions increase food safety. It help food business operators and their suppliers to be able to ensure that all stage of production, processing and distribution of food satisfy the relevant hygiene, chemical and microbiological requirements laid down in the regulations.
The objective of my research work is to investigate: Is there any, justifiable way to decrease the level of mycotoxin - within this deoxinivalenol (DON) content - of breadmaking wheat during the milling process.

Keywords:
DON-toxin, food safety, technical conditions, breadmaking wheat, food chain

1. Introduction

The source of food safety in food chain is that the primary products suit the food safety requirements. Basic requirement is that these products don't contain microbiological, chemical and other contaminations, or at least not more than the maximum allowable limits. It is a very difficult or sometimes it is not possible to correct food safety risk factors - which got into the products during cultivation - in the course of processing.
Such factor is Fusariotoxin in fodder and bread wheat. DON-toxin is the most frequent toxin in cereals.
This is a very unvarying chemical substance which stands out heat effects and doesn't decompose in the manufacturing, storage and handling procedures [1]. It follows that, if the milling industry process such raw materials, which is infected and polluted by toxin, there is this mycotoxin in processed cereals too.
The place of investigation was at the Júlia Malom Ltd, where I studied how is possible to decrease toxin content of durum wheat, and what extent by application of Sortex Z optical sorter.

2. Material and method

The experiment was built in the milling technology process of Júlia Malom Ltd consequently it wasn't a model research. The objective was to investigate, if it possible to decrease DON-toxin content of bread-making wheat and to minimize the food safety risk by application milling technology with good production practice and technological conditions. According to professional literature almost the prevention is considered as an exclusive method to keep below safe level the content of DON-toxin. That is different agritechnical and plant protection methods, best cultivation practices were suggested for farmers to cultivation. In addition must pay attention to timing of harvesting and to drying of grain of cereals within short time, as well as to assurance of good hygienic and temperature parameters of storing [1].
Sortex Z color sorter is used for cleaning of wheat in the milling technology also. The efficiency of cleaning was investigated relating to decrease of DON-toxin.
Wheat samples were taken directly before and after color-sorting for the sake of exact tracing of toxin content of relevant sample. We investigated DON-toxin content of 25 samples during the experiment. It was important for us that the initial samples must have different toxin content. This was realized by changing of mixing proportion of lots with different parameters. Every effort was made to use starter samples with DON content close to the critical level determined by law, because reduction of toxin content is principal thing in this range from the point of food safety. The samples taken before sorting by Sortex Z indicate the initial toxin content of investigated wheat. After sorting the mycotoxin decreasing efficiency of the process can be evaluated by means of analytical results of relevant samples.
Toxin analysis was carried out in own laboratory of Júlia Malom Ltd with AgraQuant Deoxinyvalenol test kit which is a quantitative enzyme-linked immunosorbent assay (ELISA) for the analysis of DON in cereals developed by Romer Labs.

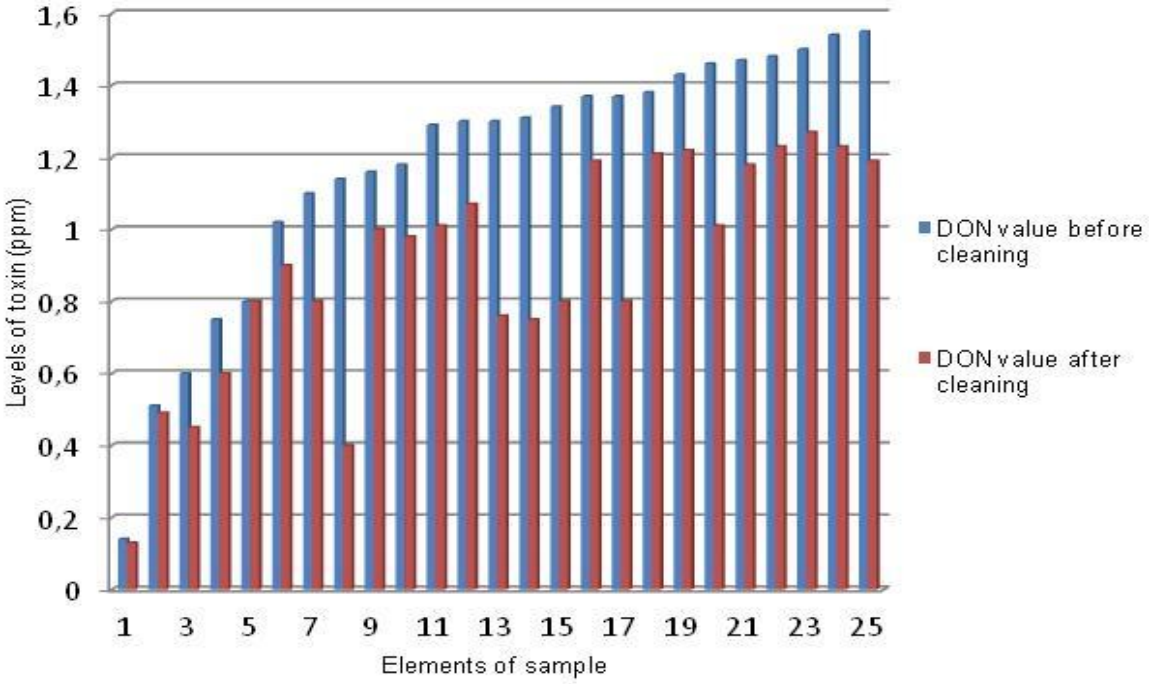

Figure 1. Reduction of DON-toxin in wheat after cleaning

Highest level of this toxin content in different products is strictly regulated in the European Union. Regulation 1881/2006/EC of the European Parliament and of Council determines the highest acceptable level of contamination. DON toxin limit in unprocessed bread wheat is 1,25 ppm, and in unprocessed durum wheat is 1,75 ppm. Allowable limits must be kept compulsorily.

3. Result and evaluation

According to measuring results Sortex Z color sorting decreased DON-toxin content of wheat (Figure 1.). But there is big difference between samples if we examine degree of decrease. It can be proved with hypothesis analysis whether the treatment was efficient or the decrease depends on chance.

In the course of hypothesis analysis two samples were compared, each involved 25 elements, and we examined toxin content before and after cleaning. Draw up the starting point: there are tandem samples with „n" elements and it is supposed those come from population with normal distribution. The arithmetic mean and standard deviation isn't known. Toxin datas of samples before cleaning is indicated by „x", and datas of cleaned wheat samples by „y". Namely:

Elements of wheat samples before cleaning (X):

$$x_i$$

Elements of cleaned wheat samples (Y):

$$y_i$$

where i= 1,…,n

According to arrangement of research samples data that belonging together were analysed by paired t-probe. The average of data before cleaning indicated μ_1-el, and standard deviation σ_1. Accordingly with this logic the average of cleaned wheat samples is μ_2, and standard deviation is σ_1. Hypothesis are following:

H_0 = null-hypothesis when there is no significant difference between theoretical mean of two samples. That is

$$\mu_1 = \mu_2$$

H_1= according to alternative hypothesis theoretical average of samples before mean is significantly higher than the average of sample after cleaning

$$\mu_1 > \mu_2$$

In this case the unilateral alternative hypothesis has sense. That prove whether the cleaning process was efficient to decrease DON-toxin content of wheat.

Calculations were carried out with MS Excel. The table demonstrates (Table 1.) the critical value of Student's t-distribution at 5% significance level less than calculated value. That is null-hypothesis should be rejected. So it can be stated the

selection by color proved to be effective in certain circumstances, at 95% probability level. Results were not induced by chance.

Table1. Two sample paired t-probe for probable value

	DON value before cleaning	DON value after cleaning
Expected value	1,1796	0,8988
Variance	0,1296	0,0939
Observations	25	25
df	24	
t value	7,3406	
P(T<=T) unpaired	6,987E-08	
t critical unpaired	1,7109	
P(T<=T) paired	1,397E-07	
t critical paired	2,0639	

DON-toxin content of wheat is food safety problem, so we have to endeavour for safety as much as possible. So it is worth to continue decrease of value α and analyse whether the efficiency of treatment is valid at lower significance level that is at higher probability level. Table 2. demonstrates clearly, color selection of wheat is effective at very low value of α, if we want to decrease DON-toxin.
We get further information about degree and characteristic of decreasing of DON-toxin by utilization of descriptive statistical data. First conclusion: DON-toxin content didn't reach the allowable limit determined in the law neither of two samples (Table 3.).

Table 2. Critical value of t-distribution at given freedom level

df	Unilateral critical values				
	0,025	0,0125	0,005	0,0025	0,0005
24	2,064	2,391	2,797	3,091	3,745

The highest value in the sample before cleaning was less by 11 % (1,55 ppm) than the maximum allowable level in durum wheat. This value was 27 % less after cleaning (1,27ppm). 80% of the elements of wheat samples contained more than 1 ppm DON-toxin before cleaning (Figure 1.). During the planning of research we endeavoured to take samples with higher mycotoxin content, because in this case decreasing is more important.

Table 3. Descriptive statistical datas of tested samples

	Wheat samples		
	Before cleaning (X)	After cleaning (Y)	Difference-sample (Z)
Expected value	1,1796	0,8988	0,2808
Standard error	0,0720	0,0613	0,0383
Standard deviation	0,3600	0,3065	0,1913
Variance	0,1296	0,0940	0,0366
Minimum	0,14	0,13	0
Maximum	1,55	1,27	0,74
Sum	29,49	22,47	7,02
Number	25	25	25

A conclusion can be drawn from expected values of two samples, that color sorting decreased toxin content of wheat on an average 24 % (μ_1=1,1796; μ_2=0,8988), which is extremely significant (Table 3.). But it shouldn't be left out of consideration, that there was big difference of decrease at certain samples (Figure 1.). In connection with this it is worthy to analyse datas of difference-sample. We get difference-sample (Z) by subtracting elements of sample X from elements of sample Y. That is:

$$z_1=x_1-y_1$$
$$.$$
$$.$$
$$.$$
$$z_i=x_i-y_i$$

Difference-sample presents that DON-toxin content decreased by 0-0,74 ppm owing to cleaning (Table 3.). Mycotoxin content, as can be seen in Figure 2. decreased by 0,1-0,5 ppm at 64% of elements and decrease was more than 0,5 ppm at 20 % of the elements. In comparison to this the rate of elements with smallest quantity toxin-decreasing (less than 0,05 ppm) is insignificant. If we look at Figure 1. and 2. together, it can be seen, that minimum toxin decreasing occurred in elements with low toxin level of X sample.

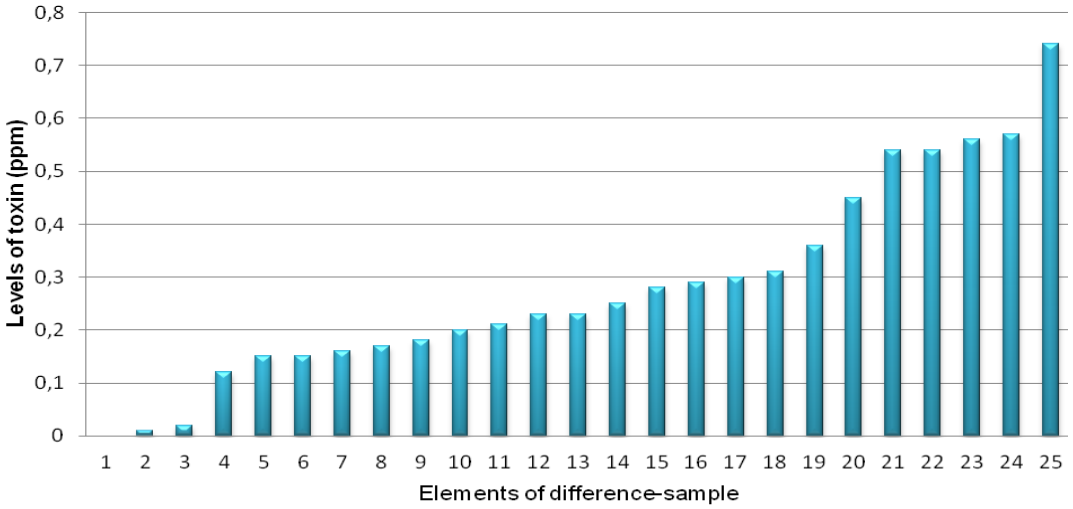

Figure 2. Value of difference-sample

Different degree of efficiency certainly derives from different characteristic of infection of grains. Relating to this there are only datas in scientific literature at present [3]. We have to test further samples to prove the effect on efficiency of cleaning and through this on food safety.

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PLANTATION PROGRAMS AND THEIR OBSERVATIONS IN THE SOUTH-EASTERN HUNGARIAN REGION

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Abstract

As a part of the environment management support programs, plantation and re-plantation take great interest. In our Soil and Plant Testing Laboratory at Faculty of Horticulture, soil samples have been analyzed continuously since 2009. Soil tests are necessary for the farmers, and the results of those tests serve as the basis of the so called "soil protection plan" made by the experts. In this investigation there have been examined the area, number, distribution and type of plantation in our region between 2009 and 2013. Most of the plantation plans were made in 2011, followed by 2012. Most plantations were vineyards. The ratio of fruit tree orchards in plantations was the highest in 2013. The average area of the planned fruit gardens was about 33% greater than that of vineyards.

Keywords:

Plantation, grape, fruit, soil analysis, south-eastern Hungary

1. Introduction

Many technological innovations within fruit production and viticulture led to increased production of fruits, grape and vine while the demand stayed almost constant. EEC (European Economic Community) intervened in the market to guarantee sales, while still keeping the freedom of planting new vineyards at the first time, not solving the problem of overproduction. After 1978, a system of „planting rights" was introduced to regulate replantations. A part of the surplus wine was distilled into industrial alcohol, in a procedure often referred as "emergency distillation". On the other hand, a shift in the demand towards higher fruit and wine quality level was also shown. Since it was realized that the vineyards on some locations would be unlikely to yield grapes of the necessary quality, increased financial incentives for giving up vineyards, so-called grubbing-up schemes, were introduced in the late 1980s. This led to reduced overproduction, but a complete balance has not been achieved so far.

Proper site and soil selection are critical for good production. It is important that the site should have good air and water drainage (to avoid frost injury and infections). The slope should be gentle enough to allow easy cultivation and spraying, without erosion. The soil for fruit plantations should have a fairly high water-holding capacity [1, 2]. Sandy soils, which are common in our region, warm up rapidly and will mature a crop few days earlier than in the clay soils. Nevertheless, sandy soil tends to be less fertile and have a lower water-holding capacity [3]. On the other hand, it is well known, that phylloxera epidemics swept across in the late 19th century, destroyed many vineyards in Europe [4]. In sandy soils common in Bács-Kiskun county, wineyards are immune to phylloxera virus in usual.

Before planting, soil samples should be taken by experts of pedology and should be analyzed in a certificated laboratory for soil physical and chemical properties: soil pH , salt, lime and organic matter, and main nutrients and ions, like phosphorus, potassium, magnesium, sodium, nitrate and main microelements (Zn, Cu, Fe, Mn), to determine if adjustments should be made before planting. The permission is given by the authorities.

2. Material and methods

The collection of soil samples have been done by registered experts of soil protection, being in connection with the Soil and Plant Testing Laboratory of the Faculty. Planned grape and fruit tree plantations were located in southern plain region of the country, mainly in Bács-Kiskun county. Soil samples were taken at the planned plantation fields of the farmers, from soil segments and topsoils, in different depths. Samples were taken in the study period between 2009 and 2013. The results of the size, place and type of plantations for each year were followed.

Analytical testing methods were made in the Soil and Plant Testing Laboratory of Faculty of Horticulture (Kecskemét College), which uses standard methods involved in the accreditation certificate (NAT-1-1548/2011).The results of the soil tests will be shown in our next study.

3. Results

There are few soil testing laboratories in our region, but the number of soil samples arriving to our laboratory is significant. Soil samples were taken in ten Hungarian counties, dominantly in our region, mainly Bács-Kiskun county (89.4%),

followed by Pest county (4.6%). The location of the plantations is shown in *Figure 1.*

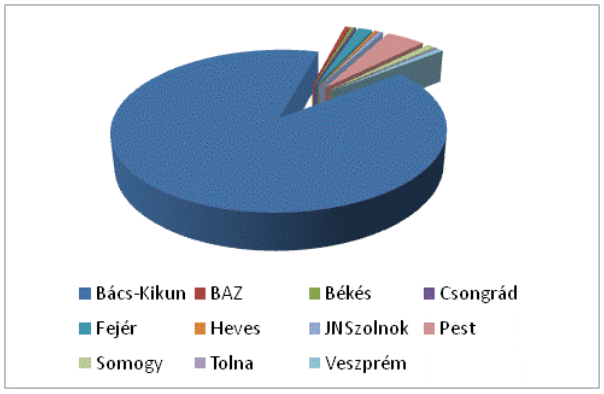

Figure 1. Location of the plantations of soils were tested in our laboratory

Between 2009 and 2013 the number of tested plantations was 520 altogether. The ratio of the number of plantations in each year is shown in *Figure 2.*

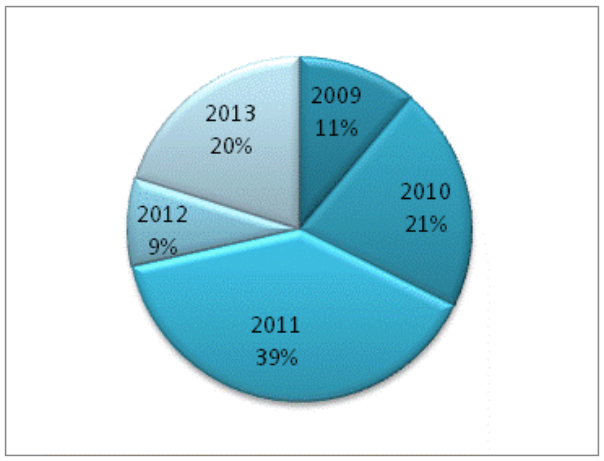

Figure 2. Ratio of the tested plantations between 2009 and 2013

The most plantations in the study period were tested in 2011 (204 pieces, 39%), followed by 2010 and 2013 (110 and 105 plantations, respectively).
The total area of the plantations was 1690.1 ha. Size of each year is shown in *Table 1*.

Table 1. Size of the tested plantations between 2009 and 2013

Year	Area (ha)
2009	205.7
2010	528.4
2011	561.8
2012	96.6
2013	291.7

The ratio of the planted area is shown in *Figure 3*.

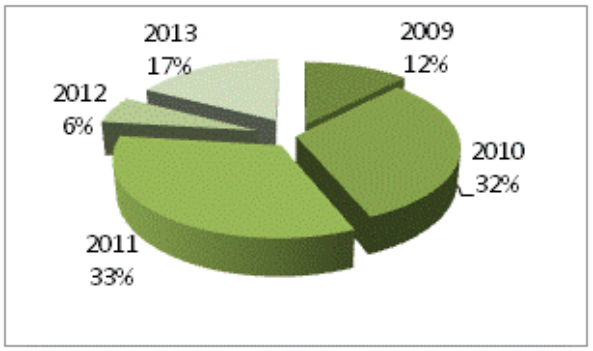

Figure 3. Distribution of the planted area from 2009 to 2013.

As shown in Table 1. and Figure 3., the largest area was planted in 2011, followed closely by 2010. Planted area was the smallest in 2012.
Our laboratory was connected with eight experts of soil protection. About ninety-seven percent of samples was taken by three of them (*Figure 4*.).

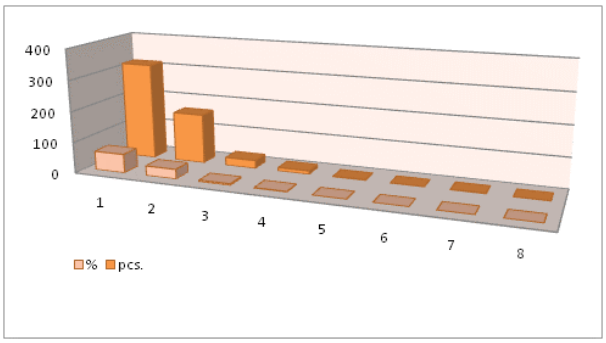

Figure 4. Number and ratio of plantations made by experts (No. 1-8)

The dominant plantations in our region were vineyards, except in 2012. Among fruit plantations the most common was apricot, cherry and plum. Favorite types of grape were white "*Cserszegi fűszeres*", "*Aletta*" and "*Arany sárfehér*". The results have been shown on *Figure 5*.

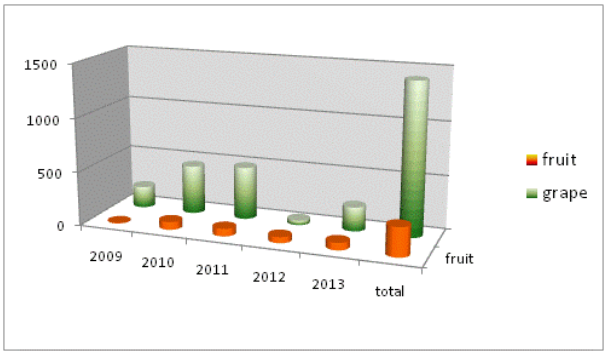

Figure 5. Size of fruit and grape plantations (ha)

4. Conclusion

A sandy loam or gravelly soil is considered best for grapes, but they will do well on many soil types. Grape is not a high nutrient demanding plant. Apart from very extreme soils (highly acidic, saline, airless meadow, bog), it is able to grow in a wide range of soils [5]. The soil should have a fairly high water-holding capacity, not be waterlogged at any time during the year [1,3]. Soil physical and chemical characteristics are very important, and should be determined before the plantation. Vineyards in Hungary represent about 2.3% of the EU, although there has been a slight declining tendency since 2004. A quarter of them lay in the south-eastern region of the country, Bács-Kiskun county represented about 22.8% in 2013. These facts are emphasizing the role of (re)plantations in our region. The results in this investigation showed that our laboratory made soil tests for 1690 ha between 2009 and 2013, representing about 8-9 percent of the total plantation area in our region. Soil tests necessary for changing grape type in plantations were made in our laboratory in large numbers in this period as well. Natural and environmentally friendly land use and agricultural farming methods are promoted and regulated in Hungary. The results of soil tests will be shown in our other study.

Acknowledgement

The authors wish to thank our experts of plant protection for the good team work from the start of the testing laboratory activity and to our colleagues for the technical assistance.

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ECONOMIC COMPARISON OF DIFFERENT CROPPING SYSTEMS FOR NIGER (*GUIZOTIA ABYSSINICA*) IN CROATIA

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Abstract

As a post-harvest crop grown after winter crops, Niger (Guizotia abyssinica) is a promising crop for oil production, forage, bio-energy plant, honey plant and green manure. Research conducted at three sites in Northeastern Croatia has been conducted as split-plot setup, with three soil tillage treatments (CT-conventional tillage, MD-multidisking, SD-single disking) and seven fertilizations treatments (G0-control, G1-KAN, granulated, G2-foliar Urea, G3-Profert Mara, G4-Profert NGT, G5-Thiofer and G6-EM Aktiv+Terrafert Blatt) in year 2013. There were no differences among soil tillage treatments, whereas G2 showed the highest niger grain yield and biomass yields. Economic comparison pointed out SD-G2 treatment as the highest income treatment.

Keywords:

Niger, *Guizotia abyssinica*, Soil tillage, Fertilization, Income

1. Introduction

Niger (*Guizotia abyssinica*) is crop originated from the Ethiopia, where had been originally grown for oil-rich seed. Its oil has high quality and medicinal use, and rest of product contains up to 37% of proteins after oil extraction. Beside human food, it can be grown for green manure, fodder for cattle and bio-mass or bio-diesel for the bio-energy. Also, it is very good honey-bee fodder, and in certain countries, such as Pakistan, presents main honey crop. Being easily grown plant, it succeeds in wide range of soils, from sandy to heavy, growth being poor only on light sandy or gravelly soils. Niger is often cultivated on very poor acid soils, on hilly slopes, where fertility is low due to leaching and washing away of the plant nutrients by erosion. Niger seed is reported to tolerate an annual precipitation of 66 to 179 cm, an annual temperature range of 13.6 to 27.5°C and a pH in the range of 5.5 to 7.5 (Quinn and Myers, 2002). It has grain yield from 200 up to 1200 kg ha^{-1}, which is rather low in comparison with sunflower and oilseed rape yields, but, it requires lower fertilizers and other crop production inputs, which, in combination with shorter growth period and lower agro-environmental requirements, provides comparative advantage of niger on certain production areas and crop systems. As an introducted crop, there is insufficient information about niger's growth and development in Croatia, so research of cropping systems and fertilization has been needed, in order to recommend the best agricultural practice for niger's production.

2. Methods

The research of the niger crop production has been carried out at three sites in the Northeastern Croatia (Vraneševci, Široko Polje and Poljanci) during 2013. Soil types were luvisol, humogley and eutric brown soil, respectively.

At all three sites the split-plot experimental design in four repetitions, with basic experimental unit of 10 m^2, has been applied after harvesting pre-crop, winter barley, at the end of July 2013.

Three main treatments of soil tillage were: CT) conventional tillage, based on shallow mouldboard ploughing at the 20 cm depth; MD) multiple discharrowing passes, 10-15 cm, and SD) single discharrowing, at 10-15 cm depth. Seven subtreatments of fertilization were: G0) control, no fertilization for niger; G1) two side-dressings by granulated KAN (27% N) with 50 kg ha^{-1} each; G2) two foliar fertilizations by urea (46% N) dissolved as 5% solution (20 kg of urea per ha); G3) two foliar applications of liquid mineral fertilizer "Profert Mara", 8 l ha^{-1} each application; G4) two foliar applications of dissolved mineral fertilizer "Profert NGT", 2 kg ha^{-1} each; G5) two foliar applications of microbial growth stimulator "Thiofer", 2 l ha^{-1} each, and G6) two foliar applications of microbial growth stimulators "EM aktiv" and "Terrafert Blatt", 8 and 1 l ha^{-1} in each application, respectively.

For each foliar application (G2-G6), main carrier was well water (400 l ha^{-1}).

Foliar fertilizer "Profert Mara" contains 7.8% of total N, 5.9% of P_2O_5, 3.4% K_2O, 1.9% Ca, 0.2% B, 0.008 Cu, 0.018% Fe, 0.011% Mn, 0.002 Zn and 0.002 Mo.

Mineral fertilizer "Profert NGT" contains grounded rock particles (d=0.1-10 µm) with 78.6% $CaCO_3$, 4.3% $MgCO_3$, 1.4% Fe_2O_3, 0.7% Al_2O_3, 9.1% SiO_2, 0.3 Na_2O, 0.05% N, 0.01% P_2O_5, 0.4% K_2O, 0.1% SO_4^{-2} and other microelements (119 ppm Mn, 69 ppm Zn, 20 ppm Cu, 3 ppm Ni, 0.7 ppm Cd, 10

ppm Pb, 4 ppm Cr, <0.05 ppm Hg, 0.6 ppm As and 0.05 ppm Mo).
Microbial growth stimulator "Thiofer" contains *Thiobacillus* spp. bacteria.
Microbial growth stimulator "EM Aktiv" and "Terrafert Blatt" contains 25 different synergistic microorganisms and folic acid, as declared by Multicraft© technology.
Niger seeding rate was 10 kg ha^{-1}, seed was manually broadcasted over the experimental surface and mixed with soil up to 3 cm depth by light spike tooth harrow passage.
Pre-seeding fertilization has not been applied, since niger supposed to be "catch crop", depending solely on side-dressings. Plant protection was also omitted, due to precaution, because there is no herbicide registered as safe for use in niger crop in Croatia.
Harvest has been picked up manually, weighted, dried and threshed for seed. Additionaly, bio-mass has been dried up 48 hours at the temperature of 65°C, in order to calculate dry bio-mass, whereas seed was weighted and recalculated at weight with 12% of seed moisture, after determining seed moisture by Dickey John moisture-meter.
Statistical data analysis has been done by split-plot ANOVA analysis, whereas statistical differences among treatments were calculated according to protected LSD method for P>0.05 probability level.
Weather pattern showed for year 2013 warmer temperatures for about 2°C than long-period average, but lower precipitations in range between 30-50% in niger vegetation period. Luckily, available water field capacity was fulfilled by previous period, so niger had favorable conditions for growth and development.
For cost/income analysis of treatments, following costs of application has been used: CT=600, MD=2 x 300, SD=300, G0=0, G1=375, G2=195. G3=136, G4=204, G5=820 and G6=362 HRK ha^{-1}. Niger seed price is 13.32 HRK kg^{-1}, whereas biomass price is 0.27 HRK kg^{-1}. In income calculations, treatment combination SD-G0 was used as income control treatment, due to lowest cost input treatment. Difference of incomes has been calculated in that way that the extra produced value from each treatment has been deducted from value achieved at SD-G0 lowest cost treatment. Differences above zero indicate justification of extra cost input, whereas results below zero indicate insupportable investment in niger production.

3. Results and discussion

Grain yield of niger, shown in Table 1, are ranging from 384 kg ha^{-1}, achieved by SD-G0 treatment, up to 656 kg ha^{-1} from treatment CT-G2.

Table 1. Niger grain yields (kg ha^{-1}) at different soil tillage and fertilization systems, 2013.

	CT	MD	SD	Avg.
G0	417 a†	391 a	384 a	398 A
G1	562 bc	533 b	526 b	540 C
G2	656 c	634 c	629 c	639 D
G3	516 a	493 b	486 b	498 BC
G4	489 ab	460 ab	452 ab	467 B
G5	495 ab	467 ab	460 ab	474 B
G6	527 b	499 b	493 b	506 BC
Avg.	523 A	497 A	490 A	

†Mean values of the soil tillage average, fertilization average and fertilization within each soil tillage average labeled with the same letter are not significantly different at P>0.05 level.

This level of grain yield is in accordance with world grain yields, which are ranging from 100-200 kg ha^{-1} in consociation with millet, up to 600 kg ha^{-1} in mono-cropping system in Kenya conditions (Duke, 1983). But, Bhardway and Gupta (1977) managed to obtain grain yields in range 1000-1200 kg ha^{-1}, although with notification that soil was very fertile. So, it is possible to obtain higher yields of niger with full scale agrotechnics in continental part of Croatia. Also, further improvements in crop selection are very plausible, since breeders in USA managed to create cultivars under the name “Early bird” and “Early bird 50” with shortened vegetation period between 50-65 days (Quinn and Myers, 2002), instead of 120-150 days for usual cultivars from India and Ethiopia. Geleta and Ortiz (2013) also mentioned that selection in Ethiopia produced high-oil content cultivars, with oil seed content of as much as 70%. Ghane et al. (2012) reported success in creation of niger cultivars with raised tolerance at water stress, which is especially important in the light of global climate warming situation.
Higher grain yields can be achieved by the use of enhanced pollination with attractants for honey bees, which can significantly increase seed mass and viability of seed (Sivaram et al., 2013).
Regarding soil tillage treatments, they weren’t significantly different, although there was a trend of higher niger grain yields with deeper soil tillage at CT treatment, if compared with MD and SD. Grain yields of different crops which were independed of different soil tillage were reported by Birkas et al. (2008), Jug et al. (2006, 2007a, 2007b) and Stipešević et al (2009, 2010, 2011) for winter wheat, soybean, buckwheat, millet and sorghum, crops which have shallower roots than maize and sunflower, where shallow soil tillage affects significantly at lower grain yields (Stipešević et al, 2000, Jug et al, 2007b).
Fertilization treatments showed significant differences of niger grain yields. The lowest grain

yield was obtained by G0, followed by G4, which showed that foliar application of fine grounded calcium rock and microelements can affect grain yield, in spite of N absence in this fertilizator. At the same level was G5, microbial growth stimulator with only a few bacterial strains. Toth et al (2010) also emphasized possibility of better nutrient uptake of crops treated with microbial growth stimulators. Higher grain yields were also reported by Haldar et al (1997) after using *Azotobacter*, which usage was comparable with 30 kg ha^{-1} N fertilizer rate. Treatment G3, with several macro- and micro-nutrients foliary applied, gave higher grain yield, statistically at the same level as KAN (G1) and effective microbes (G6), which produced, together with G2, grain yields above 500 kg ha^{-1}. It is important to emphasize that granulated fertilizer can be ineffective in the case of drought, where N can stay at the surface and crop can't uptake it from rhysosphere, as observed by Stipešević et al (2011). In that case, the best supply of N for crop is often appropriate foliar application of dissolved urea, as it was observed in niger case, but with remark that solution should not excess concentration of 5%, due to possible leaves damages by salt. Amount of N added by treatment G2 is at the already observed highest grain yield production by Paikarav et al (1997) and Singh et al (2002), who found 40 kg N ha^{-1} as the best possible N fertilization level in their research of niger grain yield. In their winter wheat trial, Stipešević et al (2009) also noticed that in the drought weather foliar application can be better than granulated fertilizers. Šimunović et al (2010) also noted that foliar fertilization of buckwheat showed at the same level of grain yield as granulated N fertilizer in similar weather conditions as niger.

Similar findings were noticed for biomass of niger, shown in Table 2, where also soil tillage treatment effects were omitted.

Table 2. Niger biomass (t ha^{-1}) at different soil tillage and fertilization systems, 2013.

	CT	MD	SD	Avg.
G0	2.997	2.973 a	2.968 a	2.979 A
G1	4.893	4.867 b	4.865 c	4.875 C
G2	5.209	5.182 c	5.179 c	5.190 C
G3	3.673	3.644 ab	3.639 a	3.652 B
G4	3.527	3.501 a	3.497 a	3.508 B
G5	3.703	3.678 ab	3.676 ab	3.686 B
G6	4.673	4.644 b	4.636 bc	4.651 C
Avg.	4.096	4.070 A	4.066 A	

†Mean values of the soil tillage average, fertilization average and fertilization within each soil tillage average labeled with the same letter are not significantly different at P>0.05 level.

The lowest fertilization treatment was G0, significantly lower than G4, G3 and G5, which was the relation rather similar as niger grain yield data. In spite of the highest yield at G2, it was not significantly different than G1 and G6 treatments.

Analysis of differences in income from grain yield of niger of different treatments in comparison with SD-G0 as the lowest cost treatment is shown in Table 3.

Table 3. Difference of incomes of grain yield production of niger in comparison with the lowest cost treatment (SD-G0), HRK ha^{-1}, 2013.

	CT	MD	SD
G0	-61	-186	0
G1	1914	1741	1927
G2	3629	3570	***3788**
G3	1409	1333	1519
G4	898	724	894
G5	391	234	419
G6	1360	1203	1405

** Treatment with the highest income difference*

It is visible that additional soil tillage from MD and CT treatments is diminishing income in most cases if compared with SD soil tillage treatment, in spite of higher grain yield production. Higher prices of more energy consumptive soil tillage operation, such as mouldboard ploughing (CT) is furthermore under the scope, due to raise of fossil fuel prices, so it is to assume that costs will be only higher.

Regarding fertilization treatments impact of income, the highest income differences were created by G2 and G1, althought, present fossil fuel based production of N fertilizers such as urea and kan share the same concern for the future, and rather high income difference can be diminished in recent future. At the other side, microbial products, such as G5 and G6, will be more and more present, which will inevitably lead toward their lower prices, so, financial effects will be better than this one. Furthermore, processes for microbial fertilizers are including organic leftovers, which can be utilized in the future for the production of additional organic fertilizers, or biomass for different purposes. Also, possibility of use of byproducts of niger oil production is for microbial production substrate, which adds toward better sustainability of the use of microbial stimulators for higher crop yields.

In Table 4 it is visible that lower price of biomass has more opportunities to omit positive financial effect of additional investment in more expensive treatments, not only soil tillage, but also fertilizers, such as G5.

Table 4. Difference of incomes of biomass production of niger in comparison with the lowest cost treatment (SD-G0), HRK ha^{-1}, 2013.

	CT	MD	SD
G0	-592	-299	0
G1	-463	-170	130
G2	-199	94	***393**
G3	-548	-256	42
G4	-655	-362	-63
G5	-1.224	-931	-632
G6	-508	-216	82

** Treatment with the highest income difference*

As for grain yield, niger's straw would be more and more interesting, due to energy requirements and alternative energy resources politics of developed nations, making possibility of higher prices of niger's straw in the future. Of course, preservation of soil properties and competition with food resources in "green energy" production should be oriented toward post-harvest periods or second crop production only, where both soil and food production are not affected by direct competition between crop production for food and energy.
Table 5 shows combined data from previous tables 3 and 4, where is even better presented higher efficiency and lower cost of foliar urea application coupled with minimum soil tillage.

Table 5. Difference of incomes of grain yield and biomass production of niger in comparison with the lowest cost treatment (SD-G0), HRK ha^{-1}, 2013.

	CT	MD	SD
G0	-654	-484	0
G1	1.451	1.571	2.056
G2	3.430	3.664	***4.181**
G3	860	1.077	1.561
G4	242	362	830
G5	-834	-698	-212
G6	852	987	1.487

** Treatment with the highest income difference*

In addition of income from grain yield and biomass, niger also can contribute to higher income by increase of high quality honey (Islam et al, 2012), which is not covered by this research, but fits perfectly along do new agrarian policy of European Union 2015-2020, when certain financial stimuli will follow additional environmental and biodiversity measures, where niger production can be additionally evaluated.

4. Conclusion

Based on the research and data analysis gathered from trials at three sites in Northeastern Croatia during 2013, following conclusions can be stated:

- production of niger as summer post-harvest crop in Northeastern Croatia is possible and profitable with minimal soil tillage and low costs at wide range of soils
- due to minimal differences in grain yield and biomass production, minimum soil tillage with one pass by discharrow can be recommended for niger crop establishment, which is also soil tillage treatment with the lowest investment
- foliar urea application can be recommended both by yield and cost effects, with due warning regarding possible leaf mass damages if applied improperly
- foliar fertilizers which proved to be at the equal level of both production and income as granulated KAN are mineral foliar fertilizer "Profert Mara" and microbial growth stimulator combination "EM Aktiv"+"Terrafert Blatt", whose application is also advisable in drought conditions when granulated KAN is failing to provide nutritive to crop, and also both of them are less adverse for environment
-other foliar treatments, "Profert NGT" and "Thiofer" can also provide higher yields in comparison with no fertilization treatment, but, their application should take into account their cost and income.

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THE EFFECT OF SOME PLANT CONDITIONING MATERIALS ON THE QUALITY AND QUANTITY OF GREEN PEPPER

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Abstract
There is an increasing demand in environmentally friendly plant growing technologies towards using natural organic material carriers. In our study, a plant conditioning product made by phosphoric acid digestion of zeolite tufa (Rioplant) was used, combined with Plantafosz Universal and Zeon A. In our study, green pepper was used as test plant in a field trial. Total crop quantity increased by 10-23%, compared to control, after using different doses of conditioning materials. According to the crop quality, vitamin C content increased by 7-34% in the fruit, depending on treatment doses.

Keywords:
Green pepper, plant conditioner, zeolite tufa, organic material, vitamin C

1. Introduction

Soil conditioner is a product which is added to soil to improve the soil quality. Soil conditioners can be used to rebuild soils which have been damaged by improper management, to make poor soils more usable, and to maintain soils in good condition. A wide variety of products can be used to manage soil quality. Soil conditioners may be used to improve water retention in dry, coarse soils, and they can be added to adjust the pH of the soil to meet the needs of specific plants [1]. Many soil conditioners come in the form of certified organic products and/or organic matter carriers in some cases. Organic material is one of the most important soil components and influences the chemical and physical properties of the soil. As organic material decomposes its nutrient content releases serving as an important source of the growing plants [2]. Zeolite containing materials may be registered in the list of materials permitted for use in ecological agricultural production. These soil additives have excellent ion-exchange properties and ability of reversible hydration and dehydration and due to their internal structure (a system of tubes and canals) suitable for these applications [3]. Zeolites increase nutrient retention; reduce environmental nutrient losses and reduce fertilizer requirements by establishing a replenishable and balanced nutrient supply in the plant root zone. Our test plant (green pepper) is usually known as a heat, water and high nutrient demanding plant [4, 5]. The aim of our study was to follow the result of the use of soil and plant conditioning materials on the growing phases, physical status and crop mass of green pepper. Vitamin C levels in pepper crop were also determined after different treatments.

2. Material and methods

In our examinations green pepper type Cecil was used as test plant; manufactured by Vegetable Searching Institute, Kecskemét. This type is offered for field growing. Experiments were carried out in the study garden of our Faculty of Horticulture in 2012. The soil of the garden is sandy soil with low humus content, moderately filled up with N, P, K nutrients. Seedlings were transplanted in the last decade of May. Pepper was planted in double rows, with 110 + 50 cm row spaces and 25 cm stem distance, resulting 5 plants/m^2. During transplantation we applied 4 repetitions, with 40-40 plants in each repetition.
Five treatments were used as follows:
1st treatment – control: normal field growing (moderate NH_4NO_3 fertilizer using) without any conditioner.
2nd treatment – 500 kg/ha Rioplant (thoroughly mixed into the soil before planting).
3rd treatment – 500 kg/ha Rioplant (thoroughly mixed into the soil before planting) + Plantafosz Universal 4 L/ha spayed into the leaves in every ten days, altogether in six cases.
4th treatment – 500 kg/ha Rioplant (thoroughly mixed into the soil before planting) + Zeon-A 4 L/ha spayed into the leaves in every ten days, altogether in six cases.
5th treatment – 500 kg/ha Rioplant (thoroughly mixed into the soil before planting) + Plantafosz Universal 4 L/ha + Zeon-A 4 L/ha spayed into the leaves in every ten days, altogether in six cases.

Applied conditioners: Rioplant (containing natural rhyolite tufa; composition is patented) is a soil conditioner protecting plants from pests, diseases and other harmful environmental impacts resulting physiologic abnormality. Plantafosz Universal

(Cheminova) strengthens the natural defenses of plants, so the use of pesticides is reduced, and also provides nutrients to the plants. Plantafosz stimulates the uptake of nutrients in the most intensively dividing plant parts in the intensive vegetative and reproductive growth stages supporting nutrient uptake in this way. Plantafosz Universal is rapidly taken up by the plants in both leaves and roots. Zeon-A is natural plant conditioning material originated from zeolite enriched with natural sulphur.
The growing phases, physical status and crop mass of green pepper were determined in the different phases of the vegetation period.
Vitamin C levels in pepper crop were determined in the Soil and Plant Testing Laboratory of Faculty of Horticulture (Kecskemét College). Our laboratory uses standard methods involved in the accreditation certificate. Vitamin C content in pepper crop was analyzed by volumetric method after extraction described previously [6].

3. Results

First harvest of pepper crop began in early August. This resulted from the relatively late plantation of the vegetable. Harvest was made in six times till the beginning of October. Most crops were collected in September. The results are shown in *Table 1. and Figure 1.*

Table 1. Crop mass (kg/m^2) in different harvesting times in 2012

Harvest date	Treatment No.				
	1	2	3	4	5
02. 08.	0.21	0.39	0.41	0.43	0.36
15. 08.	0.52	0.58	0.55	0.67	0.48
24. 08.	0.18	0.40.	0.24	0.32	0.32
06. 09.	0.33	0.37	0.44	0.28	0.33
20. 09.	0.64	0.70	0.34	0.82	0.55
02. 10.	0.75	0.85	1.01	0.84	1.17

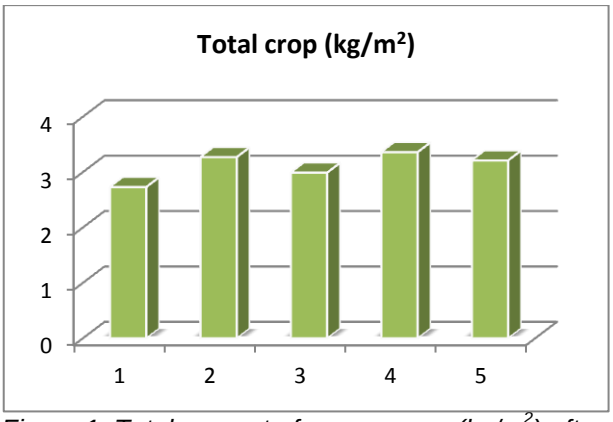

Figure 1. Total amount of pepper crop (kg/m^2) after treatment No. 1-5

The number of fruits in vegetation is shown in *Table 2*. and *Figure 2*.

Table 2. The number of pepper fruits (pieces/m^2) in different harvesting times

Harvest date	Treatment No.				
	1	2	3	4	5
02. 08.	3.44	6.08	6.20	6.31	5.18
15. 08.	7.76	8.40	8.41	9.73	7.38
24. 08.	3.99	4.23	3.91	6.02	4.97
06. 09.	5.88	7.16	6.86	5.08	5.84
20. 09.	9.56	11.26	4.73	14.47	7.99
02. 10.	12.89	15.02	17.34	15.23	19.85

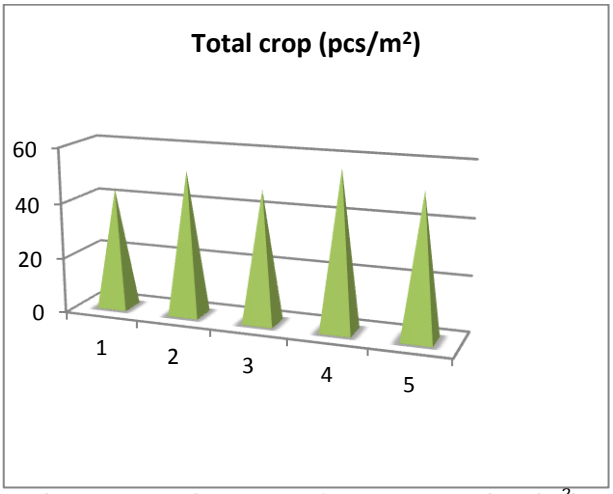

Figure 2. Total amount of pepper crop (pcs/m^2) after treatment No. 1-5

The least average crop mass was reached by treatment No. 1. (control; 2.73 kg/m^2), whereas treatment No. 4. resulted the highest crop mass (3.36 kg/m^2) . The differences among treatments respecting total crop mass, were not significant, however (SD >5%).

Physical condition of our test plants was good in the study period. Diffused occurrence of aphis and Helicoverpa armigera was observed, but not differing of the treatment type. These type of infections were common in 2012; and seemed to be harmful mainly in plant-house growing.
Vitamin C content of pepper fruits was measured in September. The results are shown in *Table 3*.

Table 3. Average vitamin C content of pepper after different treatments

Treatment number	Vitamin C (mg/100g fresh crop)
1	24.48
2	25.48
3	28.18
4	32.49
5	34.17

As seen in *Table 3*., vitamin C content was the lowest in control plants, and treatment No. 2-5 increased the level of this important (so called "Hungarian") vitamin.

4. Conclusion

Many soil conditioners are designed to improve soil structure, adding more texture to keep the soil loose. They also add essential nutrients and enrich the soil water retention ability. Our results emphasize the positive effects of soil and plant conditioning materials in the field growing of green pepper. Total amount of pepper fruit increased after using each soil and plant conditioners; total amount increased about 23% after combined use of Rioplant, Plantafosz and Zeon-A (treatment No. 4). It was the case in terms of total pieces of fruits, as well (treatment No. 4. resulted about 30% increase in fruit quantity). Pepper is known as a vegetable having high vitamin C content, representing an important source of this natural antioxidant. Our results show that combined treatment with soil and plant conditioners in vegetation (Treatment No. 4 and 5) resulted in a remarkable (about 34%) increase of this vitamin in pepper fruit. It was shown in the study of others, as well (data not shown). The results of our investigation suggest that natural conditioning materials may extend the occurrence of nutrients and/or uptake of them in vegetation. For statistical processing these tests should be repeated systematically in more replication and several times during the growing season.

Acknowledgement
The authors wish to thank to our colleagues for the technical assistance.

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PROPAGATION OF TAXUS BACCATA

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Abstract
Taxus baccata can be propagated by sowing. The seeds need to be stratified for one year before sowing. These species can be propagated by cuttings in unheated plant growing facilities from August to September, and in heated greenhouses from January to March. Taxus baccata 'Green Diamond' is currently propagated in our country by grafting and therefore it is not a widespread plant.
As part of this paper, the propagation of Taxus baccata 'Green Diamond' by cutting in various plant growth mediums with the application of root stimulants in different concentrations have been examined.
The aim of this paper was to optimise the conditions of cutting and to introduce these species for plant production.
There results confirmed that it is possible to propagate the examined species by cuttings.

Keywords:
Taxus baccata 'Green Diamond', propagated by cuttings, growth mediums, root stimulants

1. Introduction

Taxus baccata 'Green Diamond' is currently propagated by grafting in Western European ornamental tree nurseries, which is however a costly and slow propagation method. If another propagation method has been developed, it would significantly help to spread this variety. As part of this paper, the aim was to work out the propagation method for Taxus baccata 'Green Diamond' by striking. Once this technology is developed, we will be able to spread a new Taxus baccata variety, launch its production faster replace Buxus sempervirens 'Suffruticosa' and, consequently, rescue historical gardens.
'Green Diamond' – as low-grower with a spherical habit and small, dark green leaves. It tolerates pruning well and has a good renewing capacity [1].
We propagate the basic species by sowing seeds. The seeds need to be layered for a year before sowing. These species can be propagated by striking in unheated plant growing facilities from August to September, and in heated greenhouses from January to March [3].
In Western-Europe, tree nurseries almost entirely use peat as their rooting media. Pure in exceptional cases but all the more frequently mixed with coarse sand. The mixing ratio differs from nursery to nursery as well as from plant to plant but ranges between 1:3and 3:1.
The lime content of sand is generally high enough to set the required pH value, while its weight and density improves the physical properties of the peat. The cuttings can be safely strike in this mixture of peat and sand with all the possible humidifying methods. In such medium cuttings spring rich and abundantly branching roots, and retain the medium when picked.
The following three basic methods have been spreading to treat cuttings with growth promoting hormones:

- talcum powder treatment;
- short immersion in a concentrated solution;
- prolonged immersion in a thin water solution.

The lower end of the cutting has been diped1-1.5 cm deep in the 0.1-0.5% solution of the stimulant and kept immersed for 5 seconds [2].
As part of this research, the striking capacity of cuttings, effect of hormone concentration, media and cuttings quality on striking, callusing and cutting decay have been examined Furthermore the effect of hormone concentration, growth medium and cuttings quality on the number and length of the developed roots have been examined also.

2. Material and method

The propagation experiment has been performed under greenhouse conditions at Kovács Horticulture in Zalaszentgyörgy. Cuttings were planted in 104-cell nursery propagation trays. Two types of rooting media: have been used Baltic ground peat in 100% and the mixture of 30% Baltic peat, 30% horticultural perlite and 40% peat that can be easily obtained in the Zala region from Hahót. The cuttings were treated with alcoholic solutions of IBA hormone in three concentrations of 0.625%, 0.75% and 0.9375%, respectively. The cuttings were 6-8 cm long. The simple and torn cuttings have been took, and the end of the torn cuttings have been cut flat. We the cuttings were divided into two groups. The stronger ones with mass were grouped into Category I, and the slightly weaker ones with a smaller mass but still fit for propagation belonged to Category II). The weight of the 100 pieces in stronger Category I cuttings was 168g, and of the 100 pieces of weaker cuttings in Category II was 76g. There were four repetitions. The evaluation of the

experiment of 9 February 2013 was on 24 June 2013. Then the number of cuttings that had taken root by treatment and repetition were counted. The cuttings that had sprung root were removed from the propagation trays. The growth medium was cleared away from the roots of the cuttings so that the integrity, size and number of the developed roots could be determined properly. Then the number of roots was counted and the length of the roots measured by a measuring tape.
The rooted cuttings were divided into three categories according to the number of developed roots:

- very few (fewer than 2 pieces);
- few (between 3-5 pieces);
- multiple (more than 5 pieces).

Three categories were defined according to root length too:

- short rooted cuttings (maximum 1cm);
- medium long rooted cuttings (between 1-3 cm);
- long rooted cuttings (4-5 cm) (*Figure 1*).

Figure 1. Cuttings with multiple roots (more than 5) (with long roots of 4-5 cm)

The experimental data were recorded in an excel table. The measurements were evaluated by percentage calculation and variance analysis.

3. Results

On 10 May 2013 some cuttings were picked and it was noticed that the torn cuttings started to callus and shot earlier (*Figure 2*) than the simple ones that had been cut by pruning shears. Striking after callusing was already clearly observable at the time (*Figure 3*).

Figure 2. Thickening of the bottom end of the cutting and callusing on a torn cutting

Figure 3. Cuttings striking in Baltic peat (10 May 2013)

3.1. The effect of the growth media on the number of rooted cuttings

Based on the results of this examination we can state that the cuttings planted in the mixture of 30% Baltic ground peat, 30% horticultural perlite and 40% Hahót peat rooted to a larger extent irrespective of cuttings quality than those planted in purely Baltic peat (*Figure 4*).

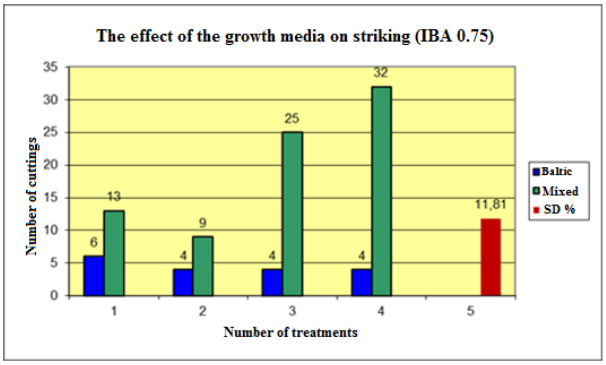

Figure 4. The effect of the growth media on the number of rooted cuttings with a 0.75% IBA hormone treatment (Zalaszentgyörgy, 2013)

3.2. The effect of hormone concentration on the number of rooted cuttings

The highest number of cuttings developed root in the mixed medium with 0.75 % IBA treatment, 79 pieces in total (*Figure 5*).
In the Baltic peat medium the highest number of cuttings rooted with a 0.625 % IBA treatment, altogether 66 pieces.
The cuttings treated with a 0.75 % and 0.9375 % IBA hormone concentration showed a significant result (*Figure 4*) in the mixed medium.

3.3. The effect of cuttings quality (mass) on the number of rooted cuttings

Cuttings quality did not influence striking to an extent that would prompt us not to use the smaller cuttings.

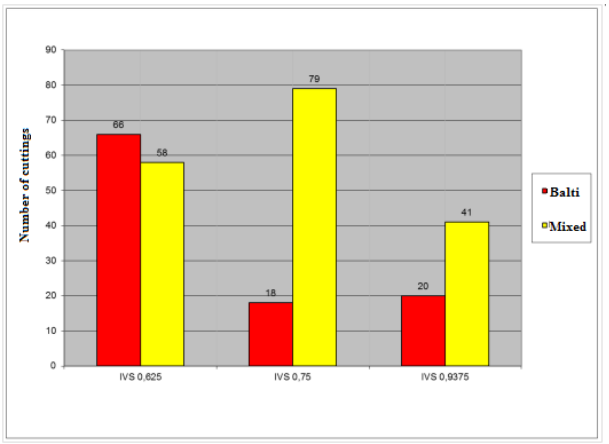

Figure 5. The effect of the medium on striking for different hormone treatments (Zalaszentgyörgy, 24 June, 2013)

3.4. The effect of the rooting media on the number of callused cuttings

In the **mixed medium** the highest number of cuttings callused with the 0.9375 % IBA treatment;153 pieces in total.
In the Baltic peat medium the highest number of cuttings callused with the 0.9375 % IBA treatment; 143 pieces in total.

3.5. The effect of hormone concentration on the number of callused cuttings

Of the cuttings treated with 0.75 % and 0.9375 % IBA hormone concentrations, respectively, those planted in the mixed medium showed a higher number of callusing (indicative of prospective striking).

3.6 The effect of cuttings quality (mass) on callused cuttings

Cuttings quality did not significantly influenced callusing.

3.7. The effect of the rooting media on the number of developed roots

In the mixed medium and with a 0.75 **%** IBA treatment altogether 16 cuttings developed roots belonging to the highest category (more than 5).
In the Baltic peat medium and with a 0.625 **%** IBA treatment altogether 31 cuttings developed roots belonging to the highest category (more than 5).

3.8. The effect of hormone concentration on the number of developed roots

The number of cuttings with more than five developed roots is the highest for cuttings treated with 0.625 % and 0.75 % IBA hormone concentrations (Table 1).

3.9. The effect of cuttings quality (mass) on the number of developed roots

Cuttings quality have not influenced the number of roots.

Table 1. The number and length of the root of rooted cuttings (Mixed medium, IBA 0.625 %)

Repetitions	Root length (cm)			Number of roots (pieces)		
	short 1-2 cm	medium-long 2-3 cm	long 3-5 cm	very few 2>	few 3-5	multiple 5<
1	8	4	2	8	4	2
2	12	3	0	12	2	1
3	9	3	3	9	2	4
4	10	4	0	10	3	1

3.10. The effect of the rooting media on the size of the developed roots

In the mixed medium and with a 0.625 % IBA treatment altogether 5 cuttings developed roots belonging to the longest category (between 3-5 cm).
In the Baltic peat medium and with a 0.625 % IBA treatment altogether 27 cuttings developed roots belonging to the longest category (between 3 and 5 cm).

3.11. The effect of hormone concentration on the size of the developed roots

As far as the effect on the length of the roots is concerned, the highest number of roots between 3-5 cm in length developed on the cuttings treated with IBA hormone with a 0.625 % concentration.

4. Conclusion

We can draw the following conclusions from the analysis of the results:

1. The significant striking and callusing relationships in the case of cuttings treated with IBA hormone in concentrations of 0.75 % and 0.9375 %, respectively, show a higher number for the cuttings planted in the mixed growth medium (*Figure 6*).
2. We can state that the cuttings planted in the mixture of 30 % Baltic ground peat, 30 % horticultural perlite and 40 % peat from Hahót struck root and got callused to a higher extent than ones planted in purely Baltic peat. It was the higher hormone concentration that caused a definite difference.
3. As far as cuttings quality is concerned, we can definitely state that stronger cuttings did not yield a large enough difference in striking tomake us abandon the use of second-class cuttings. It is all the more important a statement since in this case, considering that Taxus baccata 'Green Diamond' is a slow-growing variety developing short joints, we can utilise the small amount of raw material suitable for propagation to the largest extent possible.

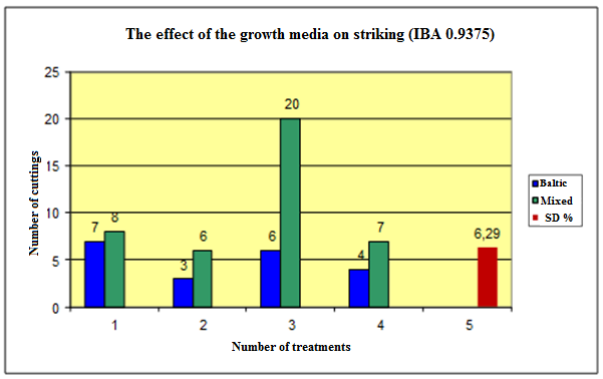

Figure 6. The effect of the growth media on the number of rooted cuttings with 0.9375 % IBA hormone treatment (Zalaszentgyörgy, 2013)

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ANALYSIS OF GROWTH AND AGE OF URBAN MATURE TREES

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Abstract
The age of trees can be estimated by measuring trunk diameter. This method can only provide approximate data, as environmental factors influence trunk diameter too. So trees at the same age may not necessary have similar trunk diameter size.
Radon testing examines the trunk diameter and age correlations in a species-specific way, but only 80-90 years of age can be derived.
In our research, we aimed to develop a plant inspection method which helps us determine the age of trees older than 100 years and raised in poor conditions in the city.

Keywords:
age of trees, trunk diameter, Radon testing

1. Introduction

We carried out our research in Szeged with the aim of finding, examining and determining the age of the trees of the parks and alleys designed and planted by the Royal Committee after the Great Flood of 1879 or the plants referring to the planting and landscaping activities of the period.
In our research, we aimed to develop a plant inspection method which helps us determine the age of trees older than 100 years, raised in poor conditions in the city.

2. Material and method

Surveying the plants, which is a crucial part of the research, we tried to find trees which were planted in the city in the first phase of the reconstruction after the great flood, during the five-year work of the Royal Committee, using Rado's age charts, the Párkányi method, the revised Párkányi method, as well as charts based on empirical age determination. As no plants were able to survive the flood, we had to find the largest trees or the ones with the largest trunk diameter appearing on the planting lists of the period. At the same time, the results of our research are only approximate, due to the fact that the Párkányi method associates age to foliage cubic metre and crown shape and because of lopping the old trees of the narrow, city streets could have lost most of their foliage, in certain cases two thirds of the maximum foliage surface, typical of free standing plants. Radon testing examines the trunk diameter and age correlations in a species-specific way, but only 80-90 years of age can be derived.
By extending Radó's chart, creating a graph we can get closer to the solution. Radó ignores the properties of the habitat and the effects of lopping on trunk diameter, as his data relates to trees with full and healthy crowns.
We represented Radó's chart in a graph and extended it (*Figure 1; 2; 3*), considering the biological properties of the plants.

3. Results

We summarised the results of the age determinations for the individual trees examined in *Table 1, 2* shows the species, place of plantation, size, health status, and deduced age of the plants.

Table 1. Survey data sheet for age determination (Szeged)

Serial number, location	Species	Girth (cm)	Diameter (cm)
1 Liget, Sissy trees, 2	Quercus robur	290	92,3
2 Liget, tennis courts	Quercus robur	470	150
3 Liget, Vigadó	Platanus x hybrid	390	124,2
4 Temesvári Boulevard	Juglans nigra	270	86
5 Dugonics Square, Tesco	Paulownia tomentosa	320	102
6 Honvéd Square	Platanus x hybrid	370	117,8
7 Honvéd Square	Acer saccharine	330	105

Table 2. Survey data sheet for age determination (Szeged)

Serial number, location	Health Status	Correction
1 Liget, Sissy trees, 2	Very bad	30% - 120 cm
2 Liget, tennis courts	Healthy	----
3 Liget, Vigadó	Lopped, good	10% - 137 cm
4 Temesvári Boulevard	Lopped, bad	20% - 103 cm
5 Dugonics Square, Tesco	Very bad	30% - 133 cm
6 Honvéd Square	Lopped, bad	20% - 141 cm
7 Honvéd Square	Lopped, bad	20% - 126 cm

The age determination for over a hundred year old trees living under city conditions is a rather difficult task. When reporting the results, it is inevitable to note that the results of the research are only possible. There is no calculation method available which could make the age determination of the trees examined more exact, as there can be large differences between individuals measuring their trunk diameter. Relying on library and archive documents we mainly examined plants in parks, boulevards and avenues (mainly in Petőfi Sándor, Kossuth Lajos, József Attila Avenue).We searched for 120-130 year old plants, although according to Radó (1999) the observations in Hungary show that considering the tree species given too, the maximum lifespan for alleys within cities is 70 years, for alleys outside cities it is 90 years.

The age determination based on foliage cubic metre calculation for city trees living under bad conditions, often lopped, couldn't be applied here. For trees living in cities we couldn't use the age determination, suggested by foresters, based on habitat patch, soil analysis and plant size either. We only had Radó's age chart left, which infers the age of a specific individual from trunk diameter. The problem with this chart is that Radó didn't examine plants over the age of 90 mentioned above. Extending Radó's chart, using the literature on the biological age, growth and lifecycle of the trees, we inferred the age of the individuals with large trunk diameter. At the same time, the values in the chart above were calculated from the data of plants with full and healthy crown.

Accordingly we needed to work out correction values to make the values calculated more exact. We determined this correction percent by examining trees of documented age or cut down trees, whose annual rings can be counted.

Our research findings include the following:

- The trunk diameter of trees in very bad condition, lopped to a great extent can be up to 30% smaller than those of healthy individuals growing in good conditions.
- The correction percent depends on the health status and growing conditions of the plant.
- By examining individuals whose age can be calculated, we set up 10, 20, 30 % correction values, with the 10% being attributed to trees with crowns almost certain to be slightly lopped, living in city surroundings, while the 30%is applied in case of plants in poor health, surrounded by concrete, growing in limited spaces.

Figure 1, 2 and 3 represent Radó's data with the yellow curve showing our extended values.

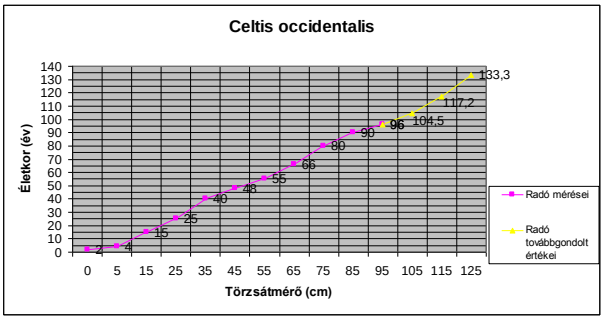

Figure 1. Age determination of Celtis occidentalises a function of trunk diameter

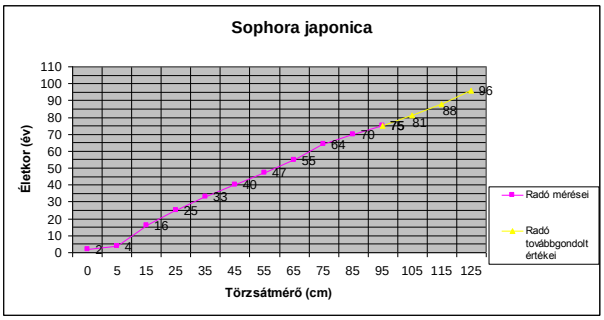

Figure 2. Age determination of Sophora japonicaas a function of trunk diameter

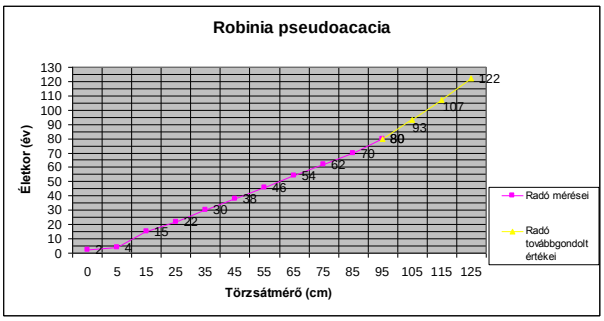

Figure 3. Age determination of Robinia pseudo acacia a function of trunk diameter

According to current research, the values above can be used in the Southern Great Plain region.

For establishing the correction values of regions, areas with different climates, we also need the local history and horticultural history data of the particular site, thus considering the differences in temperature and precipitation, which strongly affect trunk diameter growth.

4. Conclusion

Although our research shows that Radó's extended chart functions well, this kind of age determination produces only possible results, requires further research, as Radó himself has reservations about the use of his own chart for age determinations too.

The research has practical significance, as it presents horticultural historical data about the past of Szeged, providing important information for tree preservation procedures.

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COMPUTER AND INFORMATION TECHNOLOGY

QUANTUM INFORMATION, COMPUTATION AND COMMUNICATION

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Abstract

According to Moore's Law, the physical limitations of classical semiconductor-based technologies could be reached by 2020. We will then step into the Quantum Age. Quantum information processing exploits the quantum nature of information offering new possibilities and limitations. In the near future, advanced quantum communication and networking technologies driven by quantum information processing will revolutionize the traditional methods. Quantum information will help to resolve still open scientific and technical problems by expanding the boundaries of traditional computation and communication. When first quantum computers become available on the shelf, today's encrypted information will not remain secure. Does exist a cryptographic scheme at all which is proved to guarantee unconditionally secure communication in the Quantum Age? The answer is quantum cryptography, which exploits the fundamental laws of quantum mechanics to protect our future information from the power of quantum computers.

A classical communication link can transmit only classical information. Quantum channels extend the possibilities of traditional systems allowing the parties to share several different types of information. Transmission of quantum entanglement will play a crucial role in future networks and long-distance quantum communications.

In the first decade of the 21st century, many revolutionary properties of quantum information were discovered. Quantum computation and information is a new, rapidly developing interdisciplinary field. We give a brief overview the most recent results of quantum information, computation and communications.

INTERACTION-FREE MEASUREMENTS

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Abstract
Interaction-free measurements are those ones in quantum mechanics, where the position or state of an object should be detected without the occurrence of any interaction between the object and the measuring device. One of the best examples of the interaction-free measurement is the Elitzur–Vaidman bomb-testing problem. The original quantum-optical description of this quantum effect is relatively difficult. In this paper we present a new representation of it in 2-dimensional Hilbert-space with Schrödinger-picture and with the use of simple mathematics (the most advanced mathematical operation is the product of 2x2 matrices). For helping its understanding, an interactive computer-based material (available at web pages [1] (English version) or [2] (Hungarian version) is also elaborated.

Keywords:
Quantum theory, interaction, Mach-Zehnder interferometer, momentum-states representation.

1. Introduction

We are living at the beginning of a quantum revolution which will have undoubtedly a profound impact on all aspects of our life. Quantum systems, which once were restricted to the field of academic research, nowadays have been becoming a technological reality. Quantum-principles are applied in the microprocessors, in memories of computers, at the SIM-cards of mobile-telephones, even as at the bank-cards, at the optical telecommunication, beginning from the TV-screens to the CCD-cameras, at the tomography used in medical diagnostics, at the superconductive magnets, in the series of metalworking with laser, and the everyday applications can be continued infinitely. This inevitable evolution is particularly well documented in the context of information and communication technologies where the first quantum devices have been becoming available commercially.

The phenomena of the micro-universe, which have not got classical equivalent, are named quantum-effects. These peculiar phenomena are extremely suitable to stir the interest of the students and also for the illustration of quantum-theoretic way of thinking. The main goal of this paper is to bring close the quantum-theoretical way of thinking to students with a detailed description of a particular, exciting quantum-effect. Discussion of real and thought experiments which leads to paradoxical result according to classical physics can provide a motivating starting point for the introduction of the most important principles and methods of quantum mechanics.

2. The idea of the interaction-free measurement

Any physical measurement is based on a sort of physical interaction. According to the classical physics in the course of measurement the measured object and the measuring instrument are getting into common equilibrium state, for this reason we can obtain the state of measured object from the readings of the state of measuring apparatus. However, this means that in the course of measuring the state of both the measuring instrument and the object measured are changing. Consequently it is a fundamental and general requirement that during the measurements the common equilibrium state of the measuring tool and the measured object should be as near as possible to the original state of object. (It means that during the measurement the state of the measuring tool should approach toward the original state of the object measured and not reversely.)

In quantum-theory the active character of the measurements is even more sharply emphasized. Roughly speaking the state of any microphysical object can be described with the superposition of its possible eigenstates at a given moment (it means that the state function is a linear combination of the state functions of the eigenstates); the act of measurement “pushes” randomly and irreversible way (with probabilities proportional to the square of the absolute value of eigenstate functions) the object into one of its eigenstate. On macroscopic level the expectation value (calculated with the former probabilities) of the quantity can be measured.

So it seems that it is impossible to obtain information about the state of a given object without the change of its state due to the interaction occurring due to the measurement.

On the basis of genuine notion of Elitzur and Vaidman [3] let’s consider a thought experiment with a large collection of bombs, some of which are

dud. Suppose that usable bombs have a photon-triggered sensor as a detonator, if the sensor absorbs a photon the bomb explodes. The detonator of the dud bombs does not work. The problem is to be solved: how a usable bomb can be chosen without its explosion. In the frame of the classical physics the solution of the problem is impossible, because the only possibility of testing a bomb is to try it to detonate.

It is very surprising that the quantum-theory really gives eventuality to win the impossibility and select a well-functioning bomb without its explosion. Essentially an answer can be obtained to the question that whether something could have happened (in this case the explosion), which haven't happened! The philosophers name such a thing as counterfactual, in the physics it is referred as interaction-free measurement (or zero-measurement).

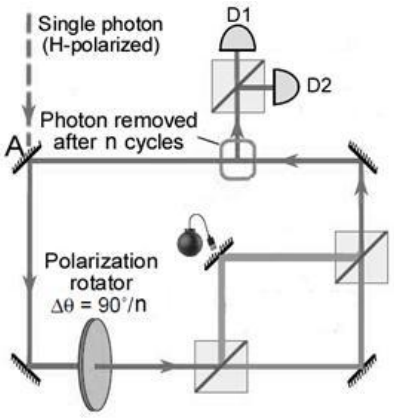

Figure 1. The experimental realization of the measuring method

The original experimental implementation of the measuring method described theoretically by Elitzur and Vaidman uses polarized light [4], and shown in Figure 1. This system consists of a big and a small circle. The small circle is essentially a modified Mach-Zehnder interferometer in which the normal beam splitters are substituted by polarising ones. These beam splitters pass horizontally polarised light and reflect vertically polarised one. Therefore, any incident light is split into horizontal and vertical components (the path of the former called as lower path while that of the latter called as upper path). These components combine again behind the second beam splitter and reproduce the original polarisation state of the beam fallen to the first beam splitter. The big circle consists of four mirrors and a polarisation rotator through which the light enters to the modified interferometer. The polarisation rotator rotates the polarisation of the light travelling through it by 90°/n.

Suppose that initially a horizontally polarized photon enters into the system at point A and makes n cycles in the system before it is allowed to go out to the detectors. At each cycle its polarization, is rotated by 90°/n, so after the n cycles the initially horizontally-polarized photon becomes vertically polarized one. Of course this conclusion is right only if the arms of the interferometer are free from any disturbing objects (for example a bomb). If, instead, there is an object in the upper path, then the evolution is totally different. For example discuss the case of n=4. During the first cycle there is only a $\sin^2(90°/n) = 0.146$ chance that the photon takes the upper path (and is absorbed). If this does not happen, then the photon wave-function is "collapsed" into the lower path and the photon is again completely horizontally polarized. The same thing happens at every cycle, until in the nth cycle it is allowed to leave the device. If the photon successfully survived (i.e., it was not absorbed) every cycle, then it is certainly horizontally polarized. Remember that without the object, the photon was definitely vertically polarized. Measuring the final state of the photon's polarization, we can decide whether an object was blocking the upper path or not. Using large number of cycles, we are able to make the probability of the absorption of a photon by an object arbitrarily small. This is the essence of interaction-free measurement.

The mathematical formalism of this implementation is relatively difficult, so below we give a simple and didactic description of this method, but the measuring system which was used in real measurements can be theoretically treated in terms of Jones matrices which formally are the same as we applied.

3. A didactic description of the interaction-free measurement

For helping the understanding, an interactive, step-by-step computer-based material is also presented [1][2].

Let's investigate our measuring device shown in Figure 2.

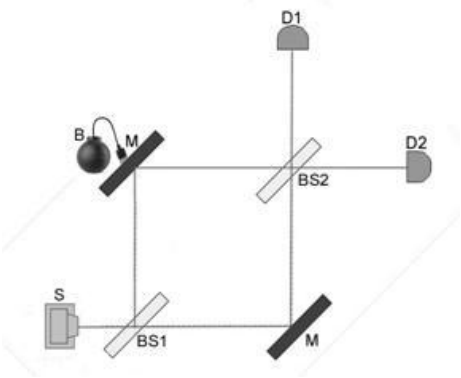

Figure 2. The Mach-Zehnder interferometer

At first consider the case without bomb. The light-beam is emitted by a highly monochromatic and coherent light-source (laser) S and it is divided in two parts by beam splitter (for example a half-

silvered mirror) BS1. One part of the beam is transmitted by the half silvered mirror and after, it is reflected by a mirror, (this will be called as "lower path" of the light) the other part which reflected from the beam splitter, is reflected by another mirror (these will be called as "upper path" of the light). After these the two beams meet a second beam splitter BS2 which divides both of them into reflecting and transmitting parts again. Reflected part of the light travelling on upper path interferes with transmitted part of the light going on the lower path at detector D1. Similarly, transmitted part of the light travelling on upper path interferes with that of reflected from which travelled on lower path at detector D2. With classical physical consideration (phase conditions of interference) one can conclude that only the detector D2 can indicate light, and light never will reach detector D1.
Let's use the device described above to test a bomb: join the detonator of the bomb to mirror M which is in the "upper path" of the interferometer. Thinking according to classical physics, the bombs with properly operating detonator explodes at the moment when the light source is switched. However, according to quantum theory one can conclude to another result. The motion of a single photon in the interferometer cannot be described with the accuracy of the classical physics. The mirror of a dud bomb can be considered as a normal mirror, so the photon-state at the beam splitter BS2 can be given as coherent superposition of photon-components running on the "upper" and the "lower" path. At the same time the mirror joined to a usable bomb provides a measuring-device because it can move due to the impact of a photon, therefore the photon-state arriving upon the beam splitter BS2 includes only the photon-component from the "lower" path. Consequently it is possible that the result measured by the detectors can be different in case of usable and dud bomb, even if the bomb does not explode.

In quantum mechanics, the *pure state of a microphysical system* is generally represented as a vector in an abstract state- (configuration space) known as a Hilbert Space. Each state vector is a column vector which is called in quantum mechanics as "ket" vector and denoted by $|\varphi\rangle$. Its *adjoint* vector is a row one and is denoted by $\langle\psi|$ *and called a* "bra" vector.
In our case the photon moves in a plane, so its momentum-state can be given with two orthogonal components, expediently with the "right" $|\rightarrow\rangle$, and "up" $|\uparrow\rangle$ momentum-components, so our space is two-dimensional. *Choose the orthonormal basis for (momentum) eigenstates of a photon in form of:*

$$\left\{|\rightarrow\rangle=\begin{pmatrix}1\\0\end{pmatrix},|\uparrow\rangle=\begin{pmatrix}0\\1\end{pmatrix}\right\}. \quad (1)$$

In the Schrödinger picture, the state of a system evolves with time. The evolution of a closed quantum system can be described by a unitary *operator* called the time evolution operator. The optical elements of the interferometer change the basis vectors of input momentum-states and this effect can be described by operators represented with 2x2 complex matrices. The most general form of these matrices is [5]:

$$\overline{\overline{U}}_{\varphi,\theta,\varphi_t,\varphi_r}=e^{i\varphi}\cdot\begin{pmatrix}e^{i\varphi_t}\cos\theta & e^{i\varphi_r}\sin\theta\\ -e^{-i\varphi_r}\sin\theta & e^{-i\varphi_t}\cos\theta\end{pmatrix}. \quad (2)$$

Using this representation let's denote the state of the photon arriving to BS1 (input state) $|in\rangle=|\rightarrow\rangle$ and that of the photon after leaving BS2 (output state) with:

$$|out\rangle=c_{\rightarrow}\cdot|\rightarrow\rangle+c_{\uparrow}\cdot|\uparrow\rangle. \quad (3.a)$$

The change of the state can be followed if along the light-paths we multiply the state vector with the matrices characterizing the optical devices. According to Figure 2 the photon reaches detector D1 and D2 with probability:

$$p(D1)=|c_{\uparrow}|^2 \quad (3.b)$$

and

$$p(D2)=|c_{\rightarrow}|^2. \quad (3.c)$$

Firstly consider our measuring device shown in Figure 2 without bomb.

It is well known from wave-theory that a wave being reflected from a mirror is suffering π radian phase-shift, as well as it is reasonable – see for example in [6] and [7] respectively – that on a lossless, symmetric beam splitter the relative phase-shift between the transmitted and reflected beam is π/2.
According to this we can choose $\varphi_t=0$ and $\varphi_r=\pi/2$ (and $\varphi=0$) values into (2) and using identity $e^{i\frac{\pi}{2}}=i$ we get:

$$\overline{\overline{BS}}_1=\overline{\overline{BS}}_\theta=\begin{pmatrix}\cos\theta & i\sin\theta\\ i\sin\theta & \cos\theta\end{pmatrix}=\begin{pmatrix}t_1 & ir_1\\ ir_1 & t_1\end{pmatrix}. \quad (4)$$

Let's look for the matrix of mirrors M $\overline{\overline{M}} = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$!

The effect of mirror M standing in angle 45° in the light-path (pair of mirrors in real situations, see Figure 2) can be written easily, if we don't forget that the reflected wave has a π phase-jump (notion above):

$|\rightarrow\rangle \Rightarrow e^{i\pi} \cdot |\uparrow\rangle$ and $|\uparrow\rangle \Rightarrow e^{i\pi} \cdot |\rightarrow\rangle$,

thus:

$$\overline{\overline{M}} = e^{i\pi} \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} = (-1) \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}. \quad (5)$$

In our measuring device the reflectivity of the BS2 beam splitter is the same as the transmittivity of the BS1 beam splitter, thus:

$$\overline{\overline{BS}}_2 = \begin{pmatrix} t_2 & ir_2 \\ ir_2 & t_2 \end{pmatrix} = \begin{pmatrix} r_1 & it_1 \\ it_1 & r_1 \end{pmatrix}. \quad (6)$$

Operator $\overline{\overline{S}}$ of the whole measuring device can be obtained by the multiplication of the matrices (4), (5) and (6) which characterize the optical elements composing the whole device:

$$\overline{\overline{S}} = \overline{\overline{BS}}_2 \cdot \overline{\overline{M}} \cdot \overline{\overline{BS}}_1 = (-i) \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}. \quad (7)$$

With this, the photon-state $|out\rangle$ after BS2 can be expressed with the incident state $|in\rangle$ at BS1:

$$|out\rangle = \overline{\overline{S}} \cdot |in\rangle = \overline{\overline{S}} \cdot |\rightarrow\rangle = (-i) \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix} = (-i) \begin{pmatrix} 1 \\ 0 \end{pmatrix} = (-i)|\rightarrow\rangle + 0 \cdot |\uparrow\rangle \quad (8)$$

The probability of the arrival of the photon to the detectors can be calculated according to (3.a)-(3.c):

$$p(D1) = |c_\uparrow|^2 = |0|^2 = 0$$
$$p(D2) = |c_\rightarrow|^2 = |(-i)|^2 = 1. \quad (9)$$

We have got back the result of the classical physics that only detector D2 records light.

After this let's study the case, when a bomb was put into the measuring device, practically the mirror M is changed for the mirror fixed to the detonator. *If the bomb is dud, then the device reduces to the basic Mach–Zehnder apparatus with no sample bomb, because the mirror fixed to the detonator behaves as a normal mirror, so only detector D2 can record light.*

If the bomb is good the mirror fixed on detonator behaves as measuring tool, thus the wave function collapses and the photon must be either on the horizontal route or on the vertical route after BS1, but not on both. Now let's track the path of the photon on the optical elements. The photon-state after BS1 can be written with the input moment-state $|in\rangle = |\rightarrow\rangle = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ as:

$$|\psi\rangle = \overline{\overline{BS}}_1 |\rightarrow\rangle = \begin{pmatrix} t_1 & ir_1 \\ ir_1 & t_1 \end{pmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix} = \begin{pmatrix} t_1 \\ ir_1 \end{pmatrix} = t_1 \begin{pmatrix} 1 \\ 0 \end{pmatrix} + ir_1 \begin{pmatrix} 0 \\ 1 \end{pmatrix} = t_1 |\rightarrow\rangle + ir_1 |\uparrow\rangle \quad (10)$$

Firstly consider the transmitted photon wave-function (in "lower" arm in Fig. 2) after BS1, thus $t_1|\rightarrow\rangle$ is reflected on M mirror:

$$\overline{\overline{M}} t_1 |\rightarrow\rangle = (-1) \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} t_1 \begin{pmatrix} 1 \\ 0 \end{pmatrix} = (-t_1) \begin{pmatrix} 0 \\ 1 \end{pmatrix} = (-t_1)|\uparrow\rangle \quad (11)$$

Thus $(-t_1)|\uparrow\rangle$ is arriving to BS2, so:

$$\overline{\overline{BS}}_2 t_1 |\uparrow\rangle = \begin{pmatrix} r_1 & it_1 \\ it_1 & r_1 \end{pmatrix} (-t_1) \begin{pmatrix} 0 \\ 1 \end{pmatrix} = \begin{pmatrix} -it_1^2 \\ -r_1 t_1 \end{pmatrix} = \left(-it_1^2\right) \begin{pmatrix} 1 \\ 0 \end{pmatrix} + (-r_1 t_1) \begin{pmatrix} 0 \\ 1 \end{pmatrix} = \left(-it_1^2\right)|\rightarrow\rangle + (-r_1 t_1)|\uparrow\rangle \quad (12)$$

will be the wave-function after BS2.

According to Fig. 2 and (3.a)-(3.c) the photon reaches detector D1 and D2 with probability

$$p(D1) = |-r_1 t_1|^2 = r_1^2 t_1^2. \quad (13.a)$$

$$p(D2) = \left|-it_1^2\right|^2 = t_1^4. \quad (13.b)$$

Secondly, follow the reflected photon (going in "upper" arm in Fig. 2 after BS1). The wave function of the photon impacting the mirror fixed on detonator is $ir_1|\uparrow\rangle$. The probability that the photon is absorbed and therefore triggers the bomb which explodes is:

$$|ir_1|^2 = r_1^2. \quad (13.c)$$

Summary: let's introduce the following labels as the possible outcomes of measurement:

(i) Indifferent measurement ("do not know that the bomb good, or dud"): the D2 detector gives signal, with probability t_1^4,
(ii) Successful (interaction-free) measurement ("there IS a good bomb"): the D1 detector gives signal, with probability $r_1^2 t_1^2$,
(iii) Failed measurement ("there WAS a good bomb"): the bomb has exploded, with probability r_1^2.

It is easy to prove that the three possible events, the probabilities of which are given by (13.a)-(13.c) constitute an entire event-space, namely the sum of probabilities is 1:

$$t_1^4 + r_1^2 t_1^2 + r_1^2 = t_1^2 \cdot \left(t_1^2 + r_1^2\right) + r_1^2 =$$
$$= t_1^2 \cdot \left(\cos^2\theta + \sin^2\theta\right) + r_1^2 =$$
$$= t_1^2 \cdot 1 + r_1^2 = \cos^2\theta + \sin^2\theta = 1 \quad .$$

As we have seen the probability of the interaction-free measurement (ifm) is $p_{ifm} = r_1^2 t_1^2$, which gives with application $t_1^2 + r_1^2 = 1$:

$$p_{ifm} = r_1^2 t_1^2 = \left(1 - t_1^2\right) t_1^2 = t_1^2 - t_1^4 \quad ,$$

thus the condition of extreme value is:

$$\frac{dp_{ifm}(t_1)}{dt_1} = 2t_1 - 4t_1^3 = 0 \quad .$$

The (non-zero) solution of equitation is $t_1 = \frac{1}{\sqrt{2}}$, which gives $\max\ p_{ifm} = p_{ifm}\left(t_1 = \frac{1}{\sqrt{2}}\right) = \frac{1}{4}$.

Thus the maximal probability of this interaction-free measurement is only 0,25, practically it means that many bombs are exploding during the tests!

An important question is that how the efficiency of the selection can be increased.

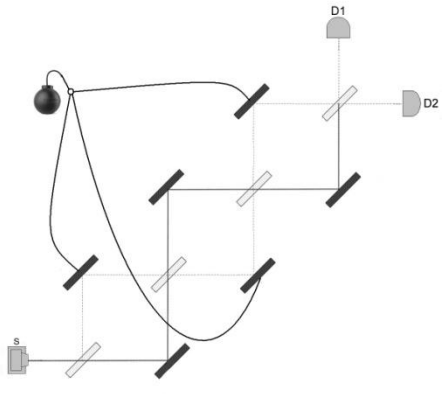

Figure 3. Our thought measuring apparatus

Figure 3 shows an improved arrangement. The incident light is reflected through a series of beam splitters, N is the number of beam splitters (In the following it is shown, that only a pair of beam splitters is necessary because the light can be lead through them several times repeatedly. The rate of the transmittivity T and reflectivity R of each BS beam splitter in the series has a special value:

$$\frac{T}{R} = ctg^2\left(\pi/2N\right). \qquad (14)$$

With comparison Figure 1 and Figure 3 it can be seen that one photon-path in the small circle on Figure 1 contains two beam splitters, thus the number of beam splitters in our implementation on Figure 3 always is even (N=2n,where n is the number of cycles in the small circle).

With apply (4) where $T = t^2 = \cos^2\theta$ and $R = r^2 = \sin^2\theta$ which according to $\frac{T}{R} = ctg^2\left(\pi/2N\right) = \frac{\cos^2\left(\pi/2N\right)}{\sin^2\left(\pi/2N\right)}$ rule (14) gives $\theta = \pi/2N$, thus:

$$t = \cos\left(\pi/2N\right) \text{ and } r = \sin\left(\pi/2N\right). \qquad (15)$$

and written back into the matrix above we get:

$$\overline{\overline{BS}} = \overline{\overline{BS}}_{\pi/2N} = \begin{pmatrix} \cos\left(\pi/2N\right) & i\sin\left(\pi/2N\right) \\ i\sin\left(\pi/2N\right) & \cos\left(\pi/2N\right) \end{pmatrix}. \qquad (16)$$

At first consider again the arrangement without bomb. It can be shown easily that $\overline{\overline{BS}}_{\pi/2N} \cdot \overline{\overline{M}} = \overline{\overline{M}} \cdot \overline{\overline{BS}}_{\pi/2N}$, namely the product is commutative, thus for the matrix $\overline{\overline{S}}_N$ of the measuring system witch contains N beam splitters and (N-1) pairs of mirror:

$$\overline{\overline{S}}_N = \overline{\overline{BS}}_{\pi/2N} \cdot \overline{\overline{M}} \cdot \overline{\overline{BS}}_{\pi/2N} \cdot \ldots \cdot \overline{\overline{M}} \cdot \overline{\overline{BS}}_{\pi/2N} \cdot \overline{\overline{M}} \cdot \overline{\overline{BS}}_{\pi/2N} =$$
$$= \overline{\overline{BS}}^{N}_{\pi/2N} \cdot \overline{\overline{M}}^{(N-1)}$$

It can be also shown that $\overline{\overline{BS}}_{\pi/2N} \cdot \overline{\overline{M}} = \overline{\overline{M}} \cdot \overline{\overline{BS}}_{\pi/2N}$, namely the product is commutative and applying the power identity $\overline{\overline{BS}}^{k}_{\theta} = \overline{\overline{BS}}_{k\theta}$ we get:

$$\overline{\overline{BS}}^{N}_{\pi/2N} = \overline{\overline{BS}}_{\pi/2} = \begin{pmatrix} \cos\pi/2 & i\sin\pi/2 \\ i\sin\pi/2 & \cos\pi/2 \end{pmatrix} = i\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix},$$

Furthermore:

$$\overline{\overline{M}}^{(N-1)} = (-1)\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}, \text{ if } N \text{ is even}$$

,

thus the matrix $\overline{\overline{S}}_N$ of the measuring system is:

$$\overline{\overline{S}}_N = \overline{\overline{BS}}^{N}_{\pi/2N} \cdot \overline{\overline{M}}^{(N-1)} = (-i)\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}, \text{ if } N \text{ is even} \qquad (17)$$

Denote the incident photon-state again *with* $|in\rangle = |\rightarrow\rangle = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$. Then the $|out\rangle$ state of photon travelled through the whole arrangement consisting of N beam splitter can be written with this input moment-state $|in\rangle = |\rightarrow\rangle = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ as:

$$|out\rangle = \overline{\overline{S}}_N |in\rangle = \overline{\overline{S}}_N |\rightarrow\rangle =$$

$$= (-i)\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}\begin{pmatrix} 1 \\ 0 \end{pmatrix} = \begin{pmatrix} -i \\ 0 \end{pmatrix} = (-i)|\rightarrow\rangle + 0 \cdot |\uparrow\rangle$$

We obtained again the result of the classical physics: only the D2 detector gives signal (with probability $(-i)^2 = 1$).

Now consider the case when a bomb is inserted into the arrangement. It can be seen in Figure 1 and Figure 3 that in case of a good bomb during n cycles the sing on D1 detector (interaction-free measuring event) can be realized only if the photon goes in the transmitted path in all *N=2n* beam splitter (if anywhere the photon goes into the reflected path hit the detonator of bomb and it explodes), thus (according to (15)) the probability of the interaction-free measurement is:

$$p_{ifm} = \left|t^N\right|^2 = \cos^{2N}\left(\frac{\pi}{2N}\right). \qquad (18)$$

If the number N becomes very large, the efficiency of the arrangement (ifm) approaches 100%!

4. Outlook

Finally some intriguing phenomena which are close connection with the interaction-free measurement are shortly cited.

To motivate students we can propound an exciting problem originating from Greek mythology. Medusa was a very dangerous monster, because a mere glimpse of Medusa immediately turns the observer to stone. Whether can we make photos about Medusa?

There are very photosensitive objects, which change their state as a consequence of colliding with even a single photon, (for example the q bits of quantum computers, or retinal purple molecules.) The interaction-free imaging is a new method developed for photography of such objects ([8]).

In our days one of the greatest challenges is the elaboration of safe cryptographic (or encryption) protocol for public channels!.(Think, for example to the electronic transfers with credit cards A new possibility for the solution of this problem can be given with a quantum key distribution model based on interaction-free measurement (see in [9]).

Readers, who like the intellectual thrills, can find a very interesting and exciting description about the quantum Russian roulette in [10].

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NETWORK SECURITY ISSUES IN REGARD TO OSI REFERENCE MODEL LAYERS

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Abstract

Today, almost all aspects of what we regard as data-in-storage and data-on-move is connected. Entire organizational infrastructure is networked and capable of inter-communication. Such capabilities offer easy reach and focus on data, which is considered a primary value to any organization or institution that possesses it.

However, with the need for high data and communications availability also comes a potential risk. Various threats can compromise and breach data integrity and confidentiality by finding a way into or "taping" regular network channels.

Computer networks based on TCP/IP stack use various layers of communication and underlying protocols respectively.

Such design can provide independent fault tolerance and ensures compatibility of equipment made from different vendors as they all adhere to open standards.

Here, we will address the issues of most common security threats on Layers 2, 3 and 4 of the OSI model, and their DoD model counterparts, as they are, by far, the most targeted by todays potential threats.

Mitigation techniques and security policies will also be mentioned as they are vital part of both data confidentiality and integrity.

Keywords:

Network, security, OSI Model, IP protocol, security issues

1. Introduction

Any network today relies on networking devices such as routers and switches. These devices form a network itself and enable creation of communication channels between devices and end users.

In their process of inter-communication, these devices use protocols which have the role of language necessary for understanding. Most of the common protocols used are developed in an open manner and adhere to certain standards, which, in return, enable devices to communicate regardless of vendor or country of origin.

Through the development of layered model, with each layer being interdependent of adherent layers, standards establishing the communication framework emerged.

Example is ISO's theoretical OSI layered model, while in practice, we encounter US DoD's IP practical model.

OSI communications model consists of seven layers which are Application, Presentation, Session, Transport, Network, Data link and Physical. Each layer houses its own protocols which cooperate in sending and receiving user and application data and passing it up and down the stack.

Their equivalents in IP model are Application layer, Transport Layer, Internet Layer and Network Interface layer, respectively.

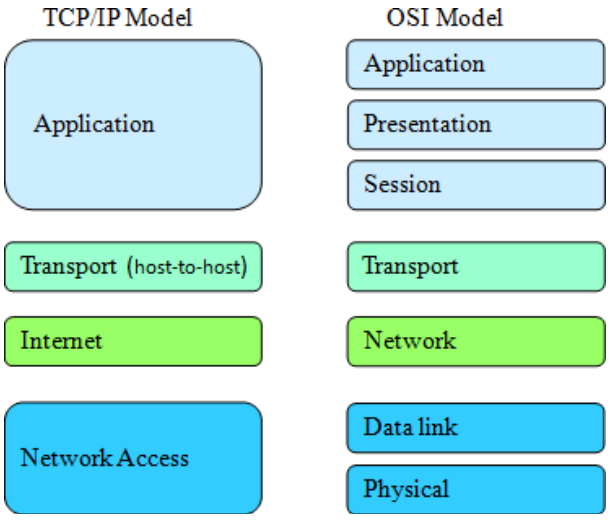

Figure 1. OSI and IP models[1]

In data protection and security, steps have to be taken to ensure secure means of data transportation between two or more endpoints.

2. Methods of protection

IP model's Application layer incorporates functions of Application, Presentation and Session layers in OSI model. Therefore, its purpose is to handle users input and application raw data values, which is the first step of communication.

Protocols domesticated on this layer are HTTP and HTTPS, POP, SMTP and IMAP, IRC, FTP and SFTP. Of course, number is quite large and, therefore, not all are listed [2].

Data protection of Application layer relies primarily on inspection of data in transit using Application layer firewalls. Such devices filter traffic primarily

by application data type and those types of devices are considered application-aware.
Ability of determining source and destination of data, application that uses it and preprogramed rules of communications, such types of devices can quickly disseminate arbitrary traffic and the potential malicious payload that lies underneath such as viruses, worms or simply a non-compliance to defined criteria.
The ability to consider and inspect traffic as a whole, throughout separate communications channels, is what gives Application layer firewalls an edge over devices that filter traffic on underlying layers of the OSI model, but also carries a need for greater quantity of computational resources.

1.	FTP	File Transfer Protocol
2.	DHCP	Dynamic Host Configuration Protocol
3.	DNS	Domain Name System
4.	NFS	Network File System
5.	SMTP	Simple Mail Transfer Protocol
6.	POP3	Post Office Protocol-3
7.	SNMP	Simple Network Management Protocol
8.	HTTP	Hyper Text Transfer Protocol
9.	BGP	Border Gateway Protocol
10.	RIP	Routing Information Protocol

Figure 2. Application layer protocols [3]

On the Transport layer of the IP and OSI models, most common protocols are TCP and UDP. These protocols are in charge of separation of data depending of the source and destination ports and application using it.
On this layer, initial segmentation of data is done and each segment or datagram, whether TCP or UDP, has an Transport layer header attached to it before its passed down the stack to a layer beneath.
Regardless of differences between TCP and UDP, and underlying mechanics, Transport layer header always contains source and destination port number.
Devices that filter traffic on Transport layer depend mostly on this given data to successfully deny, reject or allow traffic flow to a certain application or service port number.
All popular services have well known or introduced port numbers and by inspecting and matching the packet construction and payload, Transport layer firewalls can quickly differentiate between legitimate or allowed and illegitimate or arbitrary traffic and make a decision based on those criteria[4].

Source Port Number(16 bits)	Destination Port Number(16 bits)
Length(UDP Header + Data)16 bits	UDP Checksum(16 bits)
Application Data (Message)	

Figure 3. Transport layer header of the UDP datagram along with data[5]

Network layer of the OSI model, also known as IP models Internet layer is the layer where Internet traffic routing takes place. On this layer, TCP and UDP segments that are passed down get IP header attached and thus become referred to as packets. On the Internet layer, IP addresses play a major role in packet routing and relay.
Filtering packets is primarily done in that regard as well, by usage of source and destination IP addresses in each packets header (such as packet-per-packet filtering).
Network layer filtering gives the ability of allowing, dropping or denying traffic originating from one or more addresses and termed for single or multiple destinations.
Since the Network layer handles packet delivery across Internet and other IPv4 based networks, such mechanism allows the discardment of packets before sending them to higher layer (e. Transport) and thereby reducing the overhead of upper layer process and filtering.
IPs Network access layer incorporates first two layers of the OSI model; Physical and Data link, respectively. Main characteristic of this layer is that it is comprised of both physical and logical aspects of networking. Such setup allows for unified standards, and indirectly, better protection of local networking space.
Just like IP addresses are used in determining source and destination on Internet layer of IP model, in Network access layer, a concept of MAC addresses is used.
As packets are passed down to this layer, a header and a trailer are attached and thus a packet becomes referred to as frame.
Most often, communication is done via frame switching as each client's network interface card has a unique MAC (Media Access Control) address which represents them in a network.
Physical control of the network is accomplished through challenge and filtering of allowed devices upon connection initiation.
A type of firewall control can also be included in communication process which enables the setting of allow or deny decisions based on source and destination MAC addresses.
Pseudo-physical separation can also be implemented via the usage of VLAN technology, which allows grouping and isolation of chosen hosts on the network, based on various criteria such as location or purpose[3].

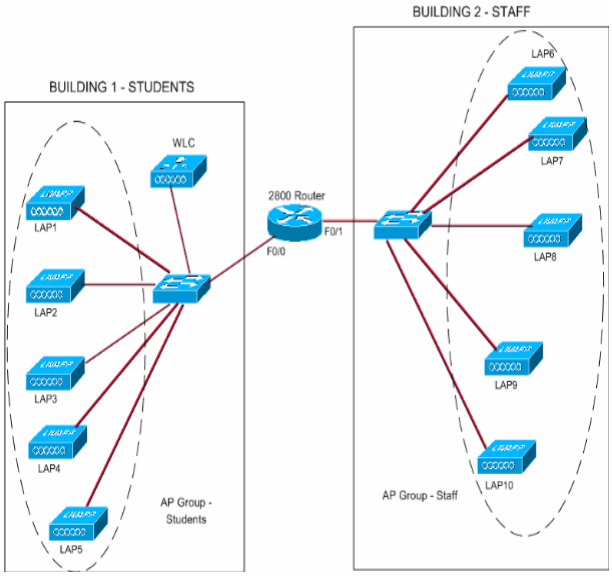

Figure 4. Topology of VLAN technologies [7]

3. Viewing the results

By using suggested methods of protection on various layers of the OSI or IP models, a certain level of granularity is achieved in network security matter that goes from more general security measures to more specific ones.

All this is achieved for the purpose of enhancing the security through combination of multiple layers of security, usually known as "Defense-in-Depth" which states that: "even if one measure fails, another one will take its place".

Along with security benefits, this type of administration allows the avoidance of congestion by permitting only traffic that passed the entire security infrastructure and also cuts down on resource overhead by stopping various threats as low as possible, without sending it up the stack.

4. Conclusion

While security issues represent a significant threat to today's enterprise environments, both from internal and external subjects, well placed preemptive security measures can minimize or almost completely mitigate large portions of risk involved with the ability to keep data access allowed purposely for legitimate use.

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ON-LINE CHANGE POINT DETECTION IN HOUSEHOLD'S ELECTRICITY POWER CONSUMPTION DATA SERIES FOR SMART GRID APPLICATIONS

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Abstract
In the previous event of TEAM conference series we presented an off-line method for estimating CPTs (Change PoinTs) in household's electricity power consumption data. The basis of the method is the Jensen-Shannon divergence (JSD) contour, and the algorithm is recursive in its nature. However, for smart grids an on-line version would be more suitable, so we have elaborated a sliding-window based algorithm, and our recent results in this respect will be presented.

Keywords:
smart grid, change-point detection, sliding window, Jensen-Shanon divergence

1. Introduction

Smart grid is new vision of future evolution of electricity systems, this concept is very important. In contrast to the present grid, smart grid is adaptively managing the balance (supply and demand) of the system, and can handle the challenge of incorporation of renewable energy resources. Therefore, the role of a household should be revised considering the power consumption/production questions. For example, novel power consumption demand is charging PHEVs' batteries, and novel power generation sources at household-level are small wind turbines, photovoltaic panels, charged batteries of electric vehicles. These increase the fluctuation in electrical energy and makes balancing more difficult.

Based on recent ICT (Information and Communication Technology) the smart meters can be used for recording and evaluating the household's power consumption in a fine time-scale (e.g. in every minute or 15 minutes) which not only results in a large database, but calls for novel machine learning methods in managing household's electrical power demand. Recently an algorithm has been proposed in [1] for categorizing the households power consumption data into smaller number of typical consumption pattern and *daily* power consumption data series have been used. For categorizing daily data the first step was the normalization the power consumption in order to be considered as a probability distribution, secondly it was modeled as a mixture-of-Gaussian type distribution, and finally as a similarity measure the Jensen-Shannon divergence has been used.

However, using finer time-resolution the problem of automatic segmentation of the power consumption data series naturally appears. Our approach for this problem is the so-called change point detection, namely determining those time-instants where statistical properties of time-series data change [2], [3]. A lot of problem in smart grids, such as automatic detection of customer categories or anomaly detection are rooting in segmentation of non-stationary time series into stationary subsequences [4], [5]. Let's note that our method is for partitioning of the power consumption data series of the same household.

In algorithm development the source of real data was the UCI Machine Learning Repository [6]. In this database there are seven data series available from December 2006 to November 2010. The sampling interval is 1 minute, the recordings are global active power, global reactive power, voltage, intensity, sub-meterings in kitchen, laundry, and water heater with air-conditioner.

The structure of the paper is the following. After the introduction, in Section 2 both the mathematical background and the previously published results in developing the off-line (or recursive) version of the method are summarized, and augmented with some novel illustrations, too. In Section 3 the on-line (sliding window-based) version is presented, and its segmentation is compared with the off-line one. Section 4 presents our preliminary results in clustering the automatically segmented data. The article ends with conclusions and acknowledgement.

2. Summary of the recursive algorithm and its application

The algorithm is based on the concept of generalized Jensen-Shannon divergence. For probability distributions $P=\{p_1,p_2,\dots,p_i,\dots p_K\}$ and $Q=\{q_1,q_2,\dots q_i,\dots q_K\}$ and for weights $\omega_A,\omega_B>0$, so that $\omega_A+\omega_B=1$, the average distribution is $A=\omega_P P+\omega_Q Q$ and using these notations the definition of generalized JSD is the following:

$$JSD(P,Q)=H\left(\omega_P P+\omega_Q Q\right)-\left[\omega_P H(P)+\omega_Q H(Q)\right] \quad (1)$$

where $H(P)=-\sum_{k=1}^{K} p_k log p_k$.denotes the Shannon-entropy. Using the generalized JSD the so-called JSD-contour can be determined. A given *N*-symbol length sequence *S* can be divided into left and right sequences in positions $n=1,\dots,N-1$. At a given position *n* the number of symbols in left sequence is *n*, whilst the number of symbols in the right sequence is $N-n$. We can now estimate the *P* and *Q* distributions for the left and right sequences using the symbols relative frequencies, and by choosing the weights as $\omega_P=\frac{n}{N}$, $\omega_Q=\frac{N-n}{N}$ the generalized JSD can be computed. Repeating this procedure for all *n* positions, we get the function $JSD(n)$, which we call JSD-contour. The candidate for estimation of CPT is the index of maximum value of the JSD-contour. In order to accept or reject this candidate CPT an approximation of probability distribution function *F(x)* of JSD_{max} has been published, so the CPT-estimation can be checked at a given p_0 confidence level. The computed index is accepted as CPT-estimate, if $F(JSD_{max})>p_0$ is hold. Much more details can be found in the relevant article [3].

Our first goal was realizing the recursive algorithm which appeared in [3]. For this the whole recording is necessary, e.g. one week long data. Then the data series is splitted into left and right sub-sequences using the index of the JSD-contour maxima (that is, using, the CPT), and this procedure is repeated until the desired level of recursion. In Figure 1 this procedure is illustrated.

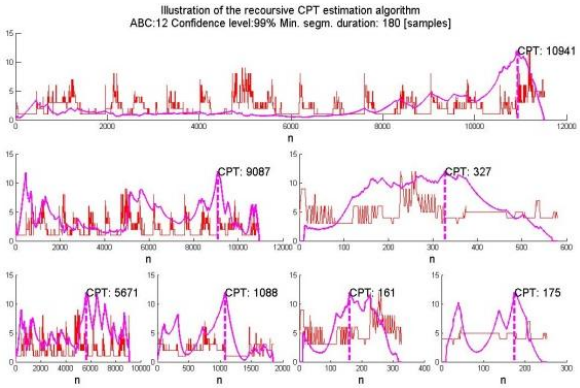

Figure 1. Illustration of the JSD-based recursive CPT detection algorithm

The statistical distribution of the left-sequence-data is different from the right-sequence one; a typical case can be seen in Figure 2.

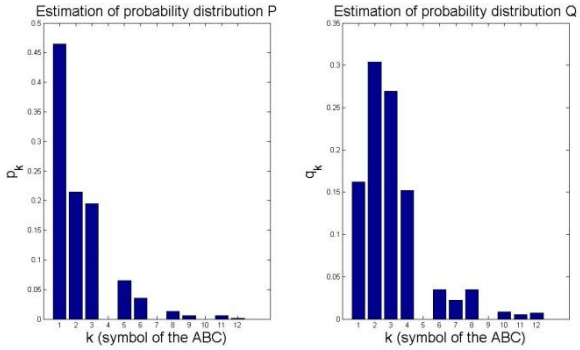

Figure 2. Estimated probability distributions of the left and right sequences (denoted by P, Q respectively)

This algorithm has been used for determining change in artificially concatenated data series using real data in case of seasonal global active power measurements. The change detection capability has also been tested similarly in case of appliances [4] (see Figures 3., 4). The automatic segmentation capability of daily measurements was presented in [5]. In order to be comparable with the recently proposed sliding window-based algorithm, we repeated the computations for different year/month/days combination (see Figure 5.).

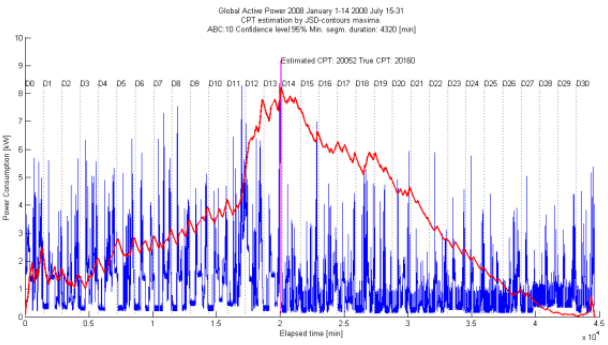

Figure 3. Seasonal change detection using the recursive algorithm.

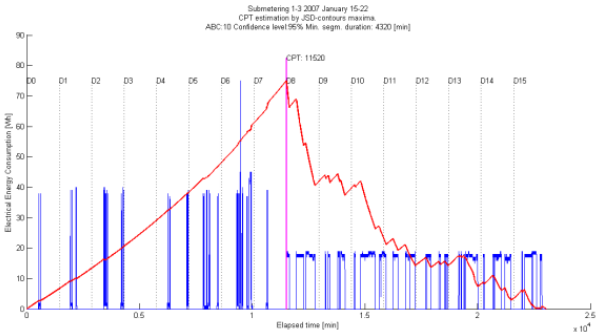

Figure 4. Appliance change detection using the off-line method.

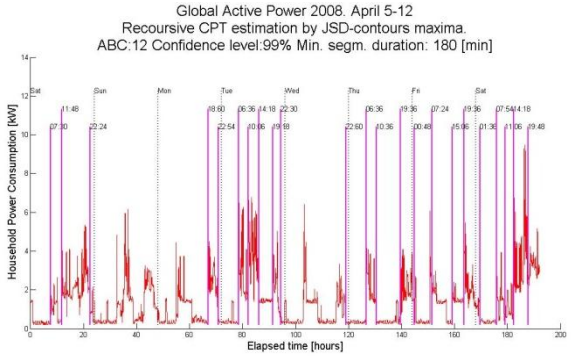

Figure 5. Automatic segmentation of global active power consumption data using the recursive CPT estimation algorithm (April 5-12, 2008)

3. Sliding window-based algorithm for on-line CPT-estimation and automatic segmentation

Because of its basically off-line nature the recursive method is not suitable for application in smart meters. Therefore, we elaborated a novel method, which is on-line and can be used in smart meters for real-time data analysis.

The basis of the method is the sliding window and a predefined statistical confidence level [3], [4], [5]. The JSD-contour is computed using the window's data and when the value of the probability distribution function at the JSD-contour's maxima lower, than the confidence level, the window is augmented with the new measurement value. This procedure is repeated until exceeding the above mentioned level. Moreover, the window-augmentation is also continued, when the length of either the left or the right sequence is lower, than a predefined minimal length. The resulted segmentation can be seen in Figure 6 using the same data as in Figure 5.

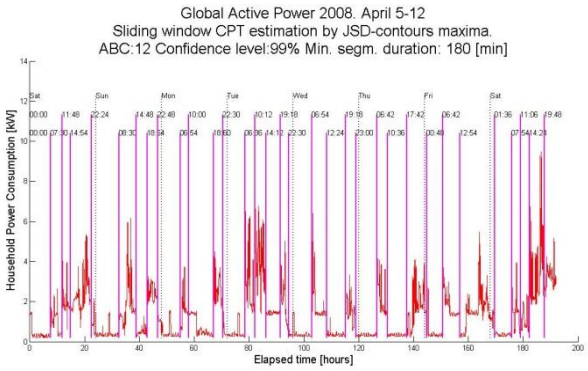

Figure 6. Automatic segmentation of the global active power data using sliding window in JSD-based CPT detection algorithm

It is important to note, that for the algorithm the symbol-sequence is necessary, not the original measured data. For this purpose a linear quantizer has been realized, which is illustrated in Figure 7.

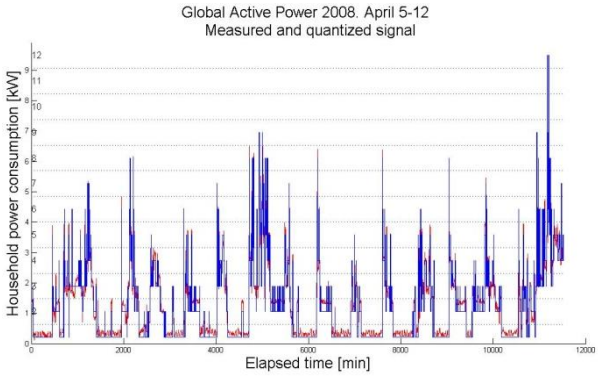

Figure 7. Generating symbol sequences from original measurements using linear quantization

When comparing the segmentation result of the recursive and the sliding window-based algorithm several differences can be observed. The cause of these, that the two algorithm deals with different symbol sub-sequences, or in other words, their 'scopes' are not the same. Moreover, the splitting process of the data into left and right subsequences in case of the sliding window based method is clear, because it deals with exactly two symbol-generating probability distributions (P and Q in Figure 2).

4. Preliminary results in clustering the segmented data

In households' electrical load balancing the existence of typical consumption patterns could be useful, for these can help in prediction of the consumption demand. Moreover, not only the consumption pattern is interesting, but its duration as well. The sliding window-based algorithm presented above automatically determines these data. Therefore, the next interesting problem is discovering similar patterns in the automatically segmented power consumption data series. This step is important because in case of existence of similar patterns a new direction of the research can be defined, namely developing nonlinear time-series prediction algorithms for predicting the next pattern and its duration.

In this paper our preliminary results in discovering the similar patterns in automatically segmented power consumption data series of a household are presented. Firstly we used distance-based clustering algorithms for this problem.

Although the results of segmentation is a doublet of <probability distribution of symbols in the segment><duration of the segment>, at first attempt we have neglected the probability distribution nature of the data. Instead, they have been considered as 12-dimensional vectors. The capabilities of two distance-based algorithms have been investigated: the hierarchical clustering which resulted in a dendrogram, and a version of k-means clustering. In both cases the L1 distance

(Manhattan-distance or 'cityblock' distance) has been used.
The time-series analyzed was "Global Active Power April 5-12 2008" data from [6]. The minimal segment duration was 180 minutes, and the sliding window based automatic segmentation algorithm has detected 32 segments. These 12 dimensional vectors were the input data set of clustering.
The resulted dendrogram can be seen in Figure 8.

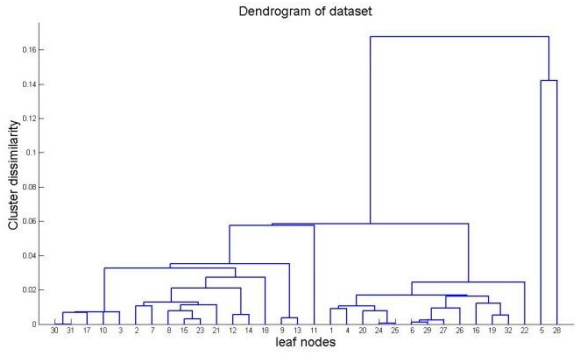

Figure 8. Dendrogram, computed from automatically segmented data using sliding window-based CPT estimation

It can be seen in the figure that there exists a similarity level where the data are acceptably well clusterable, and the number of clusters is 3 or 4. This interpretation is strengthened by the results of *k*-means clustering, which is illustrated in Figure 9 for different cluster numbers (k = 2..9). The silhouette diagram shows that 3 or 4 clusters are acceptable in this case too. For all computations we used the MATLAB software.

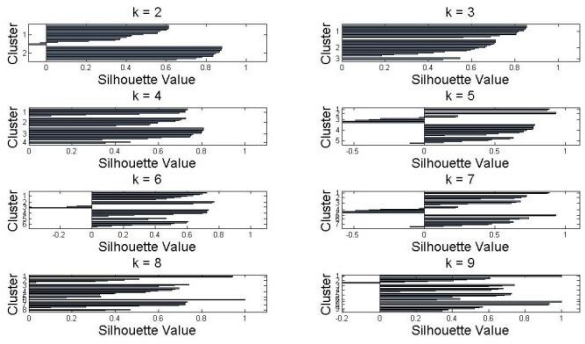

Figure 9. Silouette diagram, computed from automatically segmented data using sliding window-based CPT estimation

5. Conclusion

In this paper we proposed a novel algorithm for JSD-based CPT estimation, which is sliding window-based. By comparing it with the previously elaborated recursive algorithm we concluded, that the latter is suitable for global analysis of the data series, while the novel approach can be considered as a candidate for real-time applications. Moreover, we presented our first results in discovering similar patterns in a household's power consumption by applying hierarchical and k-means clustering methods.

Acknowledgement

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OUTLIER DETECTION IN EXPERIMENTAL DATA USING A MODIFIED EXPECTATION MAXIMIZATION ALGORITHM

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Abstract

The paper studies the problem of clustering data sets with the E-M (Expectation Maximization) algorithm. Within the E-M algorithm is implemented procedure omitting data that have a low probability of belonging to a Gaussian mixture model components. For this purpose, the threshold is determined by the rejection of data, which are considered as outliers. For this procedure is used Mahalanobis distance of the observed data to the expectations component model that describes a particular cluster. Mahalanobis distance in this situation proved to be a good choice for Gaussian mixture models that describe clusters.

Keywords:

E-M algorithm, Mahalanobis distance, data clustering, outliers

1. Introduction

This paper considers the problem of clustering (grouping) of a data set S with $m > 2$ elements in the presence of outliers [3]. Data clustering finds its application in medicine, biology, psychology, robotic visualization and navigation, image segmentation etc. [2]. For this purpose, the E-M algorithm is presented. E-M algorithm is based on the principle of soft grouping, where the boundaries between clusters are not solid. Specifically, it is a probabilistic grouping that each element of the reference data set determines the probability of belonging to each cluster. E-M algorithm is generally based on the Gaussian mixture model. Gaussian mixture model approximates the data as a linear combination of k density

$$p(x) = \sum_{i=1}^{k} w_i \, f_i(x \mid \theta_i), \qquad (1)$$

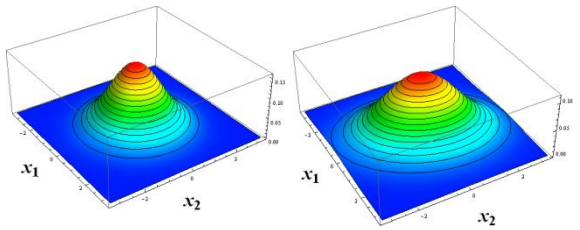
where x is l-dimensional vector, and weights w_i, $i = 1,2,\dots,k$ respectively represent the percentage of data belonging to a cluster π_i, $i = 1,2,\dots,k$, what imply $\sum_{i=1}^{k} w_i = 1$. Parameter θ_i of density function $f_i(x|\theta_i)$ in Gaussian mixture model is presented with expectation μ_i and covariance matrix Σ_i determining the density function for the normal (Gaussian) distribution, i.e. $\theta_i = (\mu_i, \Sigma_i)$. Into the E-step of E-M algorithm is implemented reduction of data which are not taken into the calculation. For that purpose the Mahalanobis distance is considered for every component of Gaussian mixture model during of algorithm execution [1],[4]. If observed data exceed appointed threshold σ from expectation μ_i for every cluster, it is not take into the calculation. In final partition such type of data are considered as an outliers. Measurement are conducted with well known Davis-Bouldin clustering index via threshold σ [5], taking into account percentage of reduced data considered as an outliers produced with modified E-M.

2. Standard E-M algorithm

As mentioned, in Gaussian mixture model clusters are presented with a linear combination of k density presented as (1). Each cluster is presented with corresponding Gaussian mixture model component, i.e. expectation μ_i and covariance matrix Σ_i. Presenting density function $f_i(x|\theta_i)$ is normal distributed, i.e.

$$f_i(x \mid \theta_i) = \frac{1}{\sqrt{(2\pi)^l \mid \Sigma_i \mid}} \exp\left(-\frac{1}{2}(x-\mu_i)^T \Sigma_i^{-1} (x-\mu_i) \right), \qquad (2)$$

where μ_i is l-dimensionaldata vector and Σ_i $l \times l$ covariance matrix. In Figure 1 is shown two illustrative example of (2) for two dimensional case, $l = 2$. In Figure 1(a) is present case with expectation $\mu = (0,0)$, and identity covariance matrix $\Sigma = I$. Figure 1(b) present case with $\mu = (0,0)$ and covariance matrix $\Sigma = \begin{bmatrix} 1.1 & 0.3 \\ 0.3 & 1.9 \end{bmatrix}$.



(a) (b)

Figure 1. PDF of Gaussian distribution

Quality of Gaussian mixture model presented with parameters $\Phi = \{(w_i, \mu_i, \Sigma_i) : i = 1, \ldots, k\}$ is measured with log-likelihood

$$L(\Phi) = \sum_{x \in S} \log\left(\sum_{i=1}^{k} w_i \, f_i(x \mid \mu_i, \Sigma_i) \right). \quad (3)$$

The process is repeated until the log-likelihood of the mixture model at the previous iteration is sufficiently close to the log-likelihood of the current model. The algorithm proceeds as follows for Gaussian mixture model:

ALGORITHM 1. (standard E-M)
STEP 0.
Initialization of parameters $\Phi^0 = \{(w_i^0, \mu_i^0, \Sigma_i^0) : i = 1, \ldots, k\}$ (zero partition), $s = 0$, and stopage criterion $\varepsilon > 0$ (set by user or at random).
STEP 1. (E step)
For every $x \in$ S calculate π_i cluster probability as

$$w_i^s(x) = \frac{w_i^s \, f_i(x \mid \mu_i^s, \Sigma_i^s)}{\sum_{n=1}^{k} w_n^s \, f_n(x \mid \mu_n^s, \Sigma_n^s)}, \quad i = 1, \ldots, k.$$

STEP 2. (M step)
Calculation of new parameters for Gaussian mixture model for every $i = 1,2, \ldots, k$:

$$w_i^{s+1} = \sum_{x \in S} w_i^s(x),$$

$$\mu_i^{s+1} = \frac{\sum_{x \in S} w_i^s(x) x}{\sum_{x \in S} w_i^s(x)},$$

$$\Sigma_i^{s+1} = \frac{\sum_{x \in S} w_i^s(x)(x - \mu_i^{s+1})(x - \mu_i^{s+1})^T}{\sum_{x \in S} w_i^s(x)}.$$

STEP 3.
If $|L(\Phi^s) - L(\Phi^{s+1})| \leq \varepsilon$ then STOP, else $s = s + 1$ and go to **STEP 1.**

E-M, like many other iterative clustering algorithms, is known to be sensitive to initial parameter values. E-M computes a local solution to the problem of maximizing the log-likelihood of the data given the model. Since this is a local optimization procedure, the quality of the local solution is dependent upon the initial parameter values. Standard practice usually calls for running E-M from many different (possibly randomly) initial parameter values and choosing the mixture model solution with best quality.

3. Mahalanobis distance

Mahalanobis distance is defined as

$$d_M(x, y) = \sqrt{(x - y)\Sigma^{-1}(x - y)^T}. \quad (4)$$

In this case, the constant distance $d_M(x, \mu) = c$ curves are ellipses (hyperellipses in general case). Indeed, the covariance matrix is symmetric and it can always be diagonalized by a unitary transform

$$\Sigma = U \Lambda U^T, \quad (5)$$

where $U^T = U^{-1}$ and $\Lambda = diag\{\lambda_1, \ldots, \lambda_l\}$ is the diagonal matrix whose elements are eigenvalues of Σ. U has as its columns the corresponding (orthonormal) eigenvectors

$$U = [v_1, v_2, \ldots, v_l]. \quad (6)$$

Combining (5) and (6) in $d_M(x, \mu) = c$, we obtain

$$(x - \mu) U \Lambda^{-1} U^T (x - \mu)^T = c^2. \quad (7)$$

Define $x' = U^T x^T$. The coordinates of x' are equal $v_k^T x$, $k = 1, \ldots, l$, that is, the projections of x onto the eigenvectors. In other words, they are the coordinates of x with respect to a new coordinate system whose axes are determined by v_k, $k = 1, \ldots, l$. Equation (8) can now be written as

$$\frac{(x_1' - \mu_1')^2}{\lambda_1} + \cdots + \frac{(x_l' - \mu_l')^2}{\lambda_l} = c^2. \quad (8)$$

This is the equation of a hyperellipsoid in the new coordinate system. The center of ellipse is μ', and the principal axes are aligned with the corresponding eigenvectors and have length $2\sqrt{\lambda_k} c$, respectively. Thus, all points having the same Mahalanobis distance from a specific point are located on an ellipse.

Example 1.
Mahalanobis distances with covariance matrix

$$\Sigma = \begin{bmatrix} 1.1 & 0.3 \\ 0.3 & 1.9 \end{bmatrix}$$

From $x = (1.0\,, 2.2)$ to two mean vectors $\mu_1 = (0\,,0)$ and $\mu_2 = (3\,,3)$ is

$$d_M^2(x, \mu_1) = (1.0\,, 2.2) \begin{bmatrix} 0{,}95 & -0{,}15 \\ -0{,}15 & 0{,}55 \end{bmatrix} (1.0\,, 2.2)^T = 2{,}952$$

and

$$d_M^2(x, \mu_2) = (-2.0\,, -0.8) \begin{bmatrix} 0{,}95 & -0{,}15 \\ -0{,}15 & 0{,}55 \end{bmatrix} (-2.0\,, -0.8)^T = 3.3672.$$

Given statement is presented with figure 2.

Notice that the given vector $x = (1.0\,,2.2)$ is closer to $\mu_2 = (3\,,3)$ with respect to the Euclidean distance. Figure 2(a) shows curves of equal Euclidean distance from the mean. They are obviously circles of radius c (hyperspheres in the general case). Figure 2(b) shows that principal

axes are aligned with the corresponding eigenvectors and have length $2\sqrt{\lambda_k}c$, respectively.

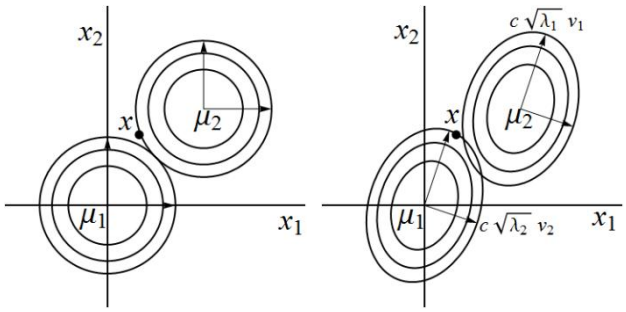


Figure 2. Mahalanobis distance

4. Modified E-M algorithm

Modification of E-M algorithm for the purpose of outlier detection is provided into the E-step. Mahalanobis distances generated with corresponding Gaussian mixture model components, i.e. expectation μ_i and covariance matrix Σ_i was used. With specified threshold σ the rejection of data is provided. The modified E-M algorithm proceeds as follows:

ALGORITHM 2. (modified E-M)
STEP 0.
Initialization of parameters $\Phi^0 = \{(w_i^0, \mu_i^0, \Sigma_i^0) : i = 1,\ldots,k\}$ (zero partition), $s = 0$, and stopage criterion $\varepsilon > 0$ (set by user or at random), and $\sigma > 0$.
STEP 1. (E step)
For every $x \in S$ calculate π_i, $i = 1,2,\ldots,k$ cluster probability in the following way.
If

$$d_M^i(x, \mu_i^s) \leq \sigma,$$

then

$$w_i^s(x) = \frac{w_i^s f_i(x \mid \mu_i^s, \Sigma_i^s)}{\sum_{n=1}^{k} w_n^s f_n(x \mid \mu_n^s, \Sigma_n^s)},$$

else

$$w_i^s(x) = 0.$$

The distance

$$d_M^i(x, \mu_i^s) = \sqrt{(x - \mu_i^s)(\Sigma_i^s)^{-1}(x - \mu_i^s)^T}$$

is Mahalanobis distance generated with corresponding Gaussian mixture model components.
STEP 2. (M step)
Calculation of new parameters for Gaussian mixture model for every $i = 1,2,\ldots,k$:

$$w_i^{s+1} = \sum_{x \in S} w_i^s(x),$$

$$\mu_i^{s+1} = \frac{\sum_{x \in S} w_i^s(x) x}{\sum_{x \in S} w_i^s(x)},$$

$$\Sigma_i^{s+1} = \frac{\sum_{x \in S} w_i^s(x)(x - \mu_i^{s+1})(x - \mu_i^{s+1})^T}{\sum_{x \in S} w_i^s(x)}.$$

STEP 3.
If $|L(\Phi^s) - L(\Phi^{s+1})| \leq \varepsilon$ then STOP, else $s = s + 1$ and go to **STEP 1.**

As standard E-M, the results from modified E-M depends of initial parameters values. For very large σ modified E-M act as standard E-M, taking into the calculation every data. Managing with threshold σ omitting data is provided which exceed from mean vector of corresponding Gaussian mixture model component. In that sense is provided better grouping characteristic and outlier detection.

5. Clustering Validity Criteria

Many different clustering validity measures exist that are very useful in practice as quantitative criteria for evaluating the quality of data partitions. Some of the most well-known validity measure, also referred to as relative validity (or quality) criteria, are possibly the Davis-Bouldin index, defined as:

$$DB = \frac{1}{k} \sum_{i=1}^{k} R_i, \tag{9}$$

where

$$R_i = \max_{i \neq j} R_{ij} \tag{10}$$

$$R_{ij} = \frac{r_i + r_j}{D_{ij}} \tag{11}$$

$$D_{ij} = d(\mu_i, \mu_j) \tag{12}$$

$$r_i = \frac{1}{m_i} \sum_{x \in \pi_i} d(x, \mu_i). \tag{13}$$

For a given assignment of clusters π_i, $i = 1,2,\ldots,k$, a lower DB index indicates better clustering. In (12), and (13) $d : R^l \times R^l \to R$ present Euclidian distance measurement, while m_i in (13) is the cardinal number of corresponding cluster π_i. It is a hard task for the user, however, to choose a specific measure when he or she

faces such a variety of possibilities. To make things even worse, new measures have still been proposed from time to time. For this reason, a problem that has been of interest for more than two decades consists of comparing the performances of existing clustering validity measures and, eventually, that of a new measure to be proposed. In our case percentage of outlier provided with modified E-M is taken into the insight. In next example we present our method for detection of outliers in observed data set.

Example 2.
On given data the standard and modified E-M are tested, i.e. Algorithm 1 and Algorithm 2. The data are clustered in three clusters (finding the optimal k partition present separable problem in data clusters analysis). In Figure 3(a) is present result of standard E-M algorithm, i.e. Algorithm 1. The results are presented with contours of linear combination of $k(=3)$ density presented with (1), while the red points presented mean vector of corresponding Gaussian mixture model component. Blue coloured data belongs to first cluster, while green belongs to second, and yellow to third. Figure 3(b) presents results of modified E-M, Algorithm 2, where black data are detected as an outliers. For threshold is observed $\sigma = 2.75$.

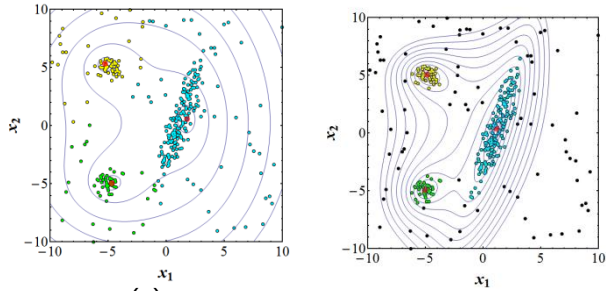


Figure 3. Clustering

Calculation of DB and outlier percentage via threshold σ of modified E-M is presented in next figure.

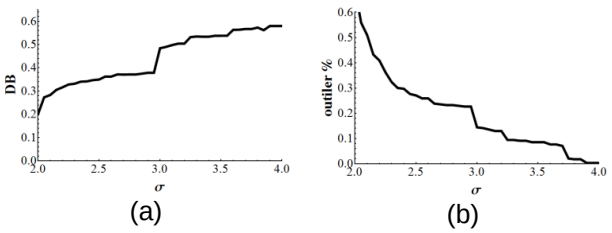


Figure 4. Clustering Validity Criteria

From measures, presented in Figure 4, we can see that the big skip at the threshold value $\sigma = 3$ is happened. This situation can be discussed as a good clustering until breakdown point at $\sigma = 3$ happened. Afterwards great account of an outliers are rejected. It can mean that the outliers are taken into the clusters, what has happened in our situation. In this situation good clustering properties are disturbed, what is presented with DB index presented in Figure 4(a). From that, a conclusion that a good outlier detection and clustering properties are happened for a values smaller then breakdown point. For a greater values of a threshold σ it can be seen that a great amount of an outliers exceeds, Figure 4(b), what implies perform of standard E-M for a large σ, and degradation of clustering quality of data with outlier presence.

6. Conclusion
Proposed modification of E-M algorithm into the E-step with Mahalanobis distance shows good properties of an outlier detection via threshold σ. Managing with σ is also established better grouping characteristic of clusters.

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JENSEN'S AND HERMITE-HADAMARD'S INEQUALITY

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Abstract
In this work, we rely on concepts of mathematical analysis such as the convexity and integral method. A derivation of the discrete form of Jensen's inequality is presented by using geometric properties of convex sets. The integral form of Jensen's inequality is realized by applying the integral method with convex combinations. Hermite-Hadamard's inequality is obtained by combining geometric properties of convex functions and integrals.

Keywords:
convexity, affinity, Jensen's inequality, Hermite-Hadamard's inequality

1. Introduction

Recall the concept of convexity and affinity. Let X be a real linear space. Let $x_1,\ldots,x_n \in \mathrm{X}$ be points (vectors), and let $\alpha_1,\ldots,\alpha_n \in \mathrm{R}$ be coefficients (scalars). Their linear combination

$$x=\sum_{i=1}^{n}\alpha_i x_i \qquad (1)$$

is convex if all coefficients α_i are nonnegative and if their sum is equal to 1. The above combination is affine if only the coefficient sum is equal to 1. The point x itself is called the combination center.

A set $\mathrm{S}\subseteq\mathrm{X}$ is convex (respectively affine) if it contains all convex (respectively affine) combinations of its points. The convex (respectively affine) hull of the set S is the smallest convex (respectively affine) set containing S, and it consists of all convex (respectively affine) combinations of points of S. The convex (respectively affine) hull of the set S is usually denoted with $\mathrm{conv}\mathrm{S}$ (respectively $\mathrm{aff}\mathrm{S}$).

We present the discrete and integral form of the famous Jensen's inequality using convex and measurable sets.

In 1905, applying mathematical induction to binomial combinations, Jensen (see [3]) has obtained the following.

Theorem A. 1 *Let C be a convex set of a real linear space, and let $\sum_{i=1}^{k}\alpha_i x_i$ be a convex combination of points $x_i\in\mathrm{C}$.*

A convex function $f:\mathrm{C}\to\mathrm{R}$ satisfies the inequality

$$f\left(\sum_{i=1}^{k}\alpha_i x_i\right)\le\sum_{i=1}^{k}\alpha_i f(x_i). \qquad (2)$$

In 1906, working on transition to integrals, Jensen (see [4]) has stated the another form.

Theorem B. 2 *Let A be a set of a measure space with positive measure μ so that $\mu(\mathrm{A})>0$, let $\mathrm{I}\subseteq\mathrm{R}$ be an interval, and let $g:\mathrm{A}\to\mathrm{R}$ be an integrable function so that $g(\mathrm{A})\subseteq\mathrm{I}$.*

A convex function $f:\mathrm{I}\to\mathrm{R}$ satisfies the inequality

$$f\left(\frac{1}{\mu(\mathrm{A})}\int_{\mathrm{A}}g(x)d\mu\right)\le\frac{1}{\mu(\mathrm{A})}\int_{\mathrm{A}}f(g(x))d\mu \qquad (3)$$

if provided that the composite function $f(g)$ is integrable.

In 1883, studying convex functions, Hermite (see [2]) has attained the important inequality. In 1893, not knowing Hermite's result, Hadamard (see [1]) has gotten its first part, the left inequality in equation (4).

Theorem C. 3 *Let $[a,b]\subset\mathrm{R}$ be a bounded closed interval with endpoints $a<b$.*

A convex function $f:[a,b]\to\mathrm{R}$ satisfies the double inequality

$$f\left(\frac{a+b}{2}\right)\le\frac{1}{b-a}\int_a^b f(x)dx\le\frac{f(a)+f(b)}{2}. \qquad (4)$$

2. Jensen's Inequality

We want to present the famous Jensen's inequality by using the convex polygon.

Let numbers $a_1,\ldots,a_n$ belong to the domain of a real convex function f. Take the corresponding graph points $A_i=(a_i,f(a_i))$. Their convex hull

$$\mathrm{A} = \mathrm{conv}\{A_1, \ldots, A_n\}$$

is convex polygon inscribed in the function epigraph

$$\mathrm{epi} f = \{(x, y) : y \geq f(x)\}.$$

If $\alpha_1, \ldots, \alpha_n$ are non-negative coefficients satisfying $\sum_{i=1}^{n} \alpha_i = 1$, then the planar convex combination $\sum_{i=1}^{n} \alpha_i A_i$, that is, its center

$$A = \sum_{i=1}^{n} \alpha_i A_i = \left(\sum_{i=1}^{n} \alpha_i a_i \ , \ \sum_{i=1}^{n} \alpha_i f(a_i) \right)$$

belongs to the polygon A. Therefore, it must be that

$$f\left(\sum_{i=1}^{n} \alpha_i a_i \right) \leq \sum_{i=1}^{n} \alpha_i f(a_i), \qquad (5)$$

as can be seen in Figure 1. The inequality in equation (6) represents the discrete form of Jensen's inequality.

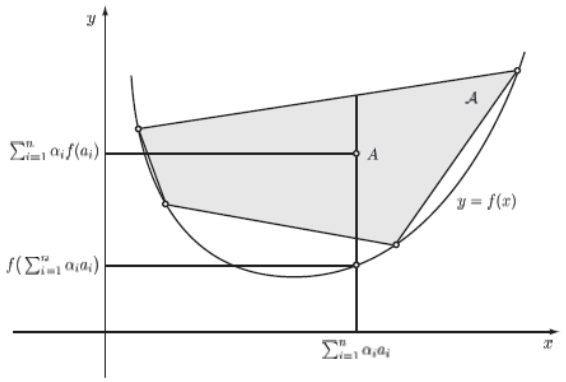

Figure 1. The geometric presentation of (5)

Remark 2.1. 4 *If f is strictly convex, then all the points A_i are vertices of the convex polygon A.*

Example 2.2. 5 *The application of Jensen' inequality to the function $f(x) = -\ln x$ and the arithmetic mean $(1/2)a^{-1} + (1/2)b^{-1}$ where a and b are positive numbers, yields the harmonic-geometric mean inequality*

$$\frac{2ab}{a+b} \leq \sqrt{ab} \qquad (6)$$

because

$$f\left(\frac{1}{2}a^{-1} + \frac{1}{2}b^{-1} \right) = \ln \frac{2ab}{a+b}$$

and

$$\frac{1}{2} f(a^{-1}) + \frac{1}{2} f(b^{-1}) = \ln \sqrt{ab}.$$

To get the integral form of Jensen's inequality inequality, we take an interval $[a,b]$ where $a < b$, and include an integrable function $g : [a,b] \to \mathrm{R}$. We assume that the image of g is contained in the domain of f, and $f(g)$ is integrable. Given the integer n, we take the points $a_{ni} = g(x_{ni})$ where $x_{ni} = a + (b-a)i/n$ assuming that $x_{n0} = a$, and the coefficients $\alpha_{ni} = 1/n = [x_{ni} - x_{ni-1}]/(b-a)$. Substituting a_{ni} and α_{ni} in the inequality in equation (5), we get

$$f\left(\frac{1}{b-a} \sum_{i=1}^{n} \left[x_{ni} - x_{ni-1} \right] g\left(x_{ni} \right) \right) \leq \frac{1}{b-a} \sum_{i=1}^{n} \left[x_{ni} - x_{ni-1} \right] f\left(g\left(x_{ni} \right) \right),$$

and letting n to infinity, we obtain the integral inequality

$$f\left(\frac{1}{b-a} \int_a^b g(x)dx \right) \leq \frac{1}{b-a} \int_a^b f\left(g(x) \right) dx. \qquad (7)$$

The inequality in equation (7) is a special case of the inequality in equation (3).

The importance of convex combinations dealing with inequalities can be seen in [5].

3. Hermite-Hadamard's Inequality

First we would like to derive the well-known Hermite-Hadamard's inequality (see [2] and [1]) in a simple way. For this purpose, two lines will be used.

Let a and b be real numbers such that $a < b$, and let $f : [a,b] \to \mathrm{R}$ be a convex function. Let $f_{\{a,b\}}^{\mathrm{cho}}$ be the function of the chord line passing through the points $A(a, f(a))$ and $B(b, f(b))$. Let $c \in (a,b)$ be an interior point, and let $f_{\{c\}}^{\sup}$ be the function of some support line passing through the point $C(c, f(c))$. Then the inequality

$$f_{\{c\}}^{\sup}(x) \leq f(x) \leq f_{\{a,b\}}^{\mathrm{cho}}(x)$$

holds for every $x \in [a,b]$. Integrating the above inequality on the interval $[a,b]$, we obtain

$$(b-a) f_{\{c\}}^{\sup}\left(\frac{a+b}{2} \right) \leq \int_a^b f(x)dx \leq (b-a) f_{\{a,b\}}^{\mathrm{cho}}\left(\frac{a+b}{2} \right), \qquad (8)$$

as evidenced by Figure 2 (it is obvious that the area of the curvilinear trapezoid is between the areas of the support and chord trapeze). Applying

the midpoint $c=(a+b)/2$ to the support line, and using the affinity of the chord line, we have

$$f^{\sup}_{\{\frac{a+b}{2}\}}\left(\frac{a+b}{2}\right)=f\left(\frac{a+b}{2}\right),$$

and

$$f^{\mathrm{cho}}_{\{a,b\}}\left(\frac{a+b}{2}\right)=\frac{1}{2}f^{\mathrm{cho}}_{\{a,b\}}(a)+\frac{1}{2}f^{\mathrm{cho}}_{\{a,b\}}(b)=\frac{f(a)+f(b)}{2}.$$

Involving the above equalities to equation (8), and dividing with $b-a$, we achieve the Hermite-Hadamard inequality

$$f\left(\frac{a+b}{2}\right)\le\frac{1}{b-a}\int_a^b f(x)dx\le\frac{f(a)+f(b)}{2}. \quad (9)$$

The discrete form

$$f\left(\frac{a+b}{2}\right)\le\sum_{i=1}^{n}\alpha_i f(a_i)\le\frac{f(a)+f(b)}{2} \quad (10)$$

holds for every convex combination $c=\sum_{i=1}^{n}\alpha_i a_i$ of points $a_i\in[a,b]$ so that the center $c=(a+b)/2$.

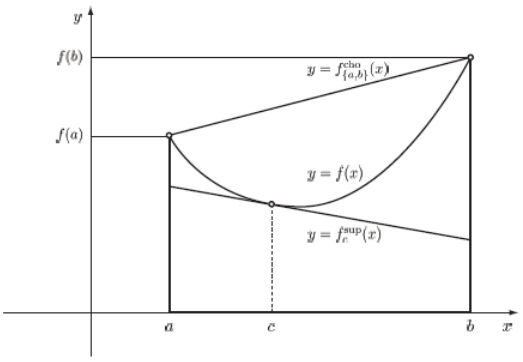

Figure 2. The geometric presentation of (8)

Remark 3.1. 6 *The support trapeze area on the left side of equation (8) attains the maximal value at the midpoint* $c=(a+b)/2$.

Example 3.2. 7 *The application of Hermite-Hadamard's inequality to the exponential function* $f(x)=e^x$ *on the interval* $[\ln a,\ln b]$ *where* $0<a<b$, *yields the geometric-logarithmic-arithmetic mean inequality*

$$\sqrt{ab}\le\frac{b-a}{\ln b-\ln a}\le\frac{a+b}{2} \quad (11)$$

because

$$f\left(\frac{\ln a+\ln b}{2}\right)=\sqrt{ab}\quad,\quad\int_{\ln a}^{\ln b}e^x dx=b-a$$

and

$$\frac{f(\ln a)+f(\ln b)}{2}=\frac{a+b}{2}.$$

4. Generalizations to Higher Dimensions

To generalize Jensen's and Hermite-Hadamard's inequality we use simplexes, sets such as the triangle and tetrahedron.

Let us show how it looks an extension and generalization of Jensen's inequality.

Theorem 4.1. 8 *Let* $\mathrm{S}\subset\mathrm{R}^k$ *be a* k*-simplex with vertices* $S_1,\ldots,S_{k+1}$, *let* $C=\sum_{i=1}^{n}\alpha_i A_i$ *be a convex combination of points* $A_i\in\mathrm{S}$, *and let* $C=\sum_{j=1}^{k+1}\sigma_j S_j$ *be the unique convex combination of simplex vertices.*

A convex function $f:\mathrm{S}\to\mathrm{R}$ *satisfies the double inequality*

$$f\left(\sum_{j=1}^{k+1}\sigma_j S_j\right)\le\sum_{i=1}^{n}\alpha_i f(A_i)\le\sum_{j=1}^{k+1}\sigma_j f(S_j). \quad (12)$$

Proof. All that matters can be done with the supporting and bounding hypreplane. We use the basic double inequality

$$f^{\mathrm{sup\,hypl}}_{\{C\}}(S)\le f(S)\le f^{\mathrm{bnd\,hypl}}_{\{S_1,\ldots,S_{k+1}\}}(S) \quad (13)$$

which applies to every $S\in\mathrm{S}$. □

A generalization of Hermite-Hadamard's inequality is as follows.

Theorem 4.2. 9 *Let* μ *be a positive measure on* R^k. *Let* $\mathrm{S}\subset\mathrm{R}^k$ *be a* k*-simplex with vertices* $S_1,\ldots,S_{k+1}$ *and positive measure* $\mu(\mathrm{S})$.

If the barycenter C *of* S *is expressed as the unique convex combination of vertices* S_j *by*

$$C=\sum_{j=1}^{k+1}\mu_j S_j, \quad (14)$$

then every convex function $f:\mathrm{S}\to\mathrm{R}$ *satisfies the double inequality*

$$f\left(\sum_{j=1}^{k+1}\mu_j S_j\right)\le\frac{1}{\mu(\mathrm{S})}\int_{\mathrm{S}}f(x_1,\ldots,x_k)d\mu\le\sum_{j=1}^{k+1}\mu_j f(S_j). \quad (15)$$

Proof. Assume that $C\notin\mathrm{int}\mathrm{S}$. If C is the vertex, then the inequality in equation (15) is reduced to the trivial double equality. If C belongs to some edge, but it is not a vertex, then we can use the inequality in equation (15) with $k=1$.

If $C\in\mathrm{int}\mathrm{S}$, we take a supporting hyperplane function $f^{\mathrm{sup\,hypl}}_{\{C\}}$. Including even the bounding hyperplane function $f^{\mathrm{bnd\,hypl}}_{\{C\}}$, we can start with the inequality in equation (13). Integrating this

inequality using the measure μ over the simplex S, we get the integral inequality. Applying the affinity of $f_{\{C\}}^{\text{sup hypl}}$ and $f_{\{C\}}^{\text{bnd hypl}}$, we obtain

$$\int_S f_{\{C\}}^{\text{sup hypl}}(x_1,\ldots,x_k)d\mu = \mu(S) f\left(\sum_{j=1}^{k+1}\mu_j S_j\right)$$

and

$$\int_S f_{\{S_1,\ldots,S_{k+1}\}}^{\text{bnd hypl}}(x_1,\ldots,x_k)d\mu = \mu(S)\sum_{j=1}^{k+1}\mu_j f(S_j),$$

which combined with the integral inequality yields the required equation (15). □

5. Conclusion

As the two most important inequalities, Jensen's and Hermite-Hadamard's inequality deserve any further serious study.

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POWER AND LOGARITHMIC MEANS

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Abstract
The article consists of two parts. The first part deals with quasi-arithmetic means and convex functions. In the second part, using quasi-arithmetic means, we perform power and logarithmic means of two positive numbers. Such well-known means are arithmetic, geometric, harmonic, logarithmic and identric. Power and logarithmic means are the mathematical basis for the presentation of different types of entropies.

Keywords:
convex function, quasi-arithmetic means, power means, logarithmic means

1. Introduction

Some research fields close to mathematics in the basis of their work use estimations between the two superior states expressed by the numerical values a and b. So we are talking about the means ranging between a and b, concerning inequalities in mathematics and entropies in applied sciences.
The branch of mathematical inequalities is focused to convex sets and convex functions of a real linear space X. A set $\mathrm{A} \subseteq \mathrm{X}$ is convex if it contains the line segments connecting all pairs of its points (all binomial convex combinations $\alpha_1 A_1 + \alpha_2 A_2$ of points $A_1, A_2 \in \mathrm{A}$ and non-negative coefficients $\alpha_1, \alpha_2 \in \mathrm{R}$ satisfying $\alpha_1 + \alpha_2 = 1$). A function $f : \mathrm{A} \to \mathrm{R}$ is convex if the inequality

$$f(\alpha_1 A_1 + \alpha_2 A_2) \le \alpha_1 f(A_1) + \alpha_2 f(A_2) \quad (1)$$

holds for all binomial convex combinations in A.
Using the mathematical induction, it can be proved that a convex set contains all finite convex combinations of its points, and that every convex function satisfies the inequality in (1) for all finite convex combinations in A. Similar is true for affine sets and functions.

2. Quasi-Arithmetic Means

Every convex combination $c = \sum_{i=1}^{n} \alpha_i a_i$ of numbers a_i such that $a_{\min} = a < a_{\max} = b$ can be reduced to the binomial form $c = \alpha a + \beta b$, where $\alpha = (b-c)/(b-a)$ and $\beta = (c-a)/(b-a)$. So, the means between the two given numbers are preferred. To generalize a notion of the arithmetic mean of numbers a and b, we use a strictly monotone continuous function $\varphi : [a,b] \to \mathrm{R}$ assuming that $a < b$. Theorem 2.2 indicates the way in which two specific means can be compared, and it is the main section result.
The discrete quasi-arithmetic mean of the numbers a and b respecting the function φ is defined by the number

$$M_{\varphi}^{\mathrm{dis}}(a,b) = \varphi^{-1}\left(\frac{\varphi(a)+\varphi(b)}{2}\right). \quad (2)$$

The integral quasi-arithmetic mean of the numbers a and b respecting φ is the number

$$M_{\varphi}^{\mathrm{int}}(a,b) = \varphi^{-1}\left(\frac{1}{b-a}\int_a^b \varphi(x)dx\right). \quad (3)$$

The discrete or integral quasi-arithmetic mean $M_{\varphi}(a,b)$ is in $[a,b]$ because the numbers in parentheses are in $\varphi([a,b])$. These means satisfy the affinity property, that is, the equality

$$M_{\alpha\varphi+\beta}(a,b) = M_{\varphi}(a,b) \quad (4)$$

holds for every pair of numbers $\alpha \neq 0$ and β.

Lemma 2.1.10 *Let $f : [a,b] \to \mathrm{R}$ be a convex function. Let $[c,d] \subset [a,b]$ be a subinterval such that $c < d$ and*

$$\frac{c+d}{2} = \frac{a+b}{2}. \quad (5)$$

Then

$$\frac{f(c)+f(d)}{2} \le \frac{f(a)+f(b)}{2} \quad (6)$$

and

$$\frac{1}{d-c}\int_c^d f(x)dx \le \frac{1}{b-a}\int_a^b f(x)dx. \quad (7)$$

Proof of Lemma 2.1. Let us prove the integral inequality in equation (7). Put $\mathrm{A} = [c,d]$, $|\mathrm{A}| = d-c$, $\mathrm{B} = [a,b]$ and $|\mathrm{B}| = b-a$. Assuming equation (5), and applying the affinity of the function $f_{\{c,d\}}^{\mathrm{cho}}$, we obtain the equalities

$$\frac{1}{|\mathrm{A}|}\int_{\mathrm{A}} f^{\mathrm{cho}}_{\{c,d\}}(x)dx = \frac{1}{|\mathrm{B}|}\int_{\mathrm{B}} f^{\mathrm{cho}}_{\{c,d\}}(x)dx = \frac{1}{|\mathrm{B}\setminus\mathrm{A}|}\int_{\mathrm{B}\setminus\mathrm{A}} f^{\mathrm{cho}}_{\{c,d\}}(x)dx. \quad (8)$$

Using equation (8), and the fact that $f(x) \le f^{\mathrm{cho}}_{\{c,d\}}(x)$ for all $x \in \mathrm{A}$ as well as $f^{\mathrm{cho}}_{\{c,d\}}(x) \le f(x)$ for all $x \in \mathrm{B}\setminus\mathrm{A}$, we get

$$\frac{1}{|\mathrm{A}|}\int_{\mathrm{A}} f(x)dx \le \frac{1}{|\mathrm{A}|}\int_{\mathrm{A}} f^{\mathrm{cho}}_{\{c,d\}}(x)dx = \frac{1}{|\mathrm{B}\setminus\mathrm{A}|}\int_{\mathrm{B}\setminus\mathrm{A}} f^{\mathrm{cho}}_{\{c,d\}}(x)dx \le \frac{1}{|\mathrm{B}\setminus\mathrm{A}|}\int_{\mathrm{B}\setminus\mathrm{A}} f(x)dx. \quad (9)$$

Now the binomial convex combination

$$L_r(a,b) = \begin{cases} \left[\dfrac{a^r - b^r}{r(a-b)}\right]^{\frac{1}{r-1}}, & r \neq 0,1,\ a \neq b \\ \dfrac{a-b}{\ln a - \ln b}, & r = 0,\ a \neq b \\ \dfrac{1}{e}\left[\dfrac{a^a}{b^b}\right]^{\frac{1}{a-b}}, & r = 1,\ a \neq b \\ a, & a = b \end{cases}. \quad (10)$$

provides the inequality in equation (7). □

Relying on the above lemma, we can prove the next rule for comparison of discrete or integral quasi-arithmetic means $M_\varphi(c,d)$ and $M_\varphi(a,b)$.

Theorem 2.2. 11 *Let $\varphi:[a,b]\to\mathrm{R}$ be a strictly monotone continuous function. Let $[c,d]\subset[a,b]$ be a subinterval such that $c<d$ and*

$$\frac{c+d}{2} = \frac{a+b}{2}. \quad (11)$$

If φ is either convex and increasing or concave and decreasing, then

$$M_\varphi(c,d) \le M_\varphi(a,b). \quad (12)$$

If φ is either convex and decreasing or concave and increasing, then the reverse inequality is valid in equation (12).

Having two strictly monotone continuous functions $\varphi,\psi:[a,b]\to\mathrm{R}$, we say that the function ψ is φ-convex if the composition function $\psi(\varphi^{-1})$ is convex. In order to compare quasi-arithmetic means M_φ and M_ψ, we rely on the details presented in the following theorem.

Theorem A. 12 *Let $\varphi,\psi:[a,b]\to\mathrm{R}$ be strictly monotone continuous functions.*
If ψ is either φ-convex and increasing or φ-concave and decreasing, then

$$M_\varphi(a,b) \le M_\psi(a,b). \quad (13)$$

If ψ is either φ-convex and decreasing or φ-concave and increasing, then the reverse inequality is valid in equation (13).

The inequality in equation (13) is strict if ψ is either strictly φ-convex or strictly φ-concave. Different forms of quasi-arithmetic means have been considered in [2].
The quasi-arithmetic mean inequality in equation (13) is graphically presented in Figure 3. The point $M(\varphi(M_\varphi(a,b)),\psi(M_\psi(a,b)))$ is located at the chord line in the discrete case, and M is located between the curve graph and chord line in the integral case.

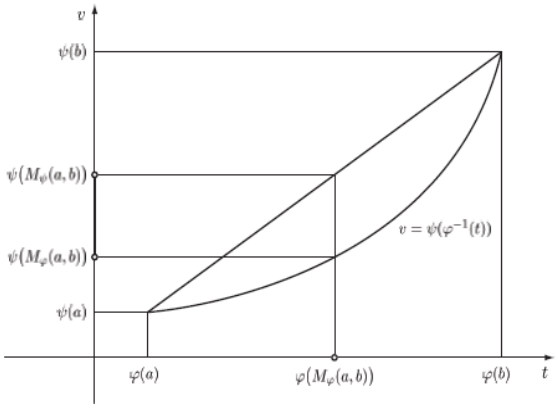

Figure 1. Graphic presentation of equation (13)

3. Power and Logarithmic Means

Power means are investigated and used as a special case of quasi-arithmetic means. These means apply the power function $\varphi(x) = x^r$. Logarithmic means arise by continuous extending of power means. The main result of the section is the presentation of Theorem 3.2 determining the order of power and logarithmic means.
Take positive numbers a and b, and consider the discrete mean

$$M^{\mathrm{dis}}_{\varphi(x)=x^r}(a,b) = \left[\frac{a^r + b^r}{2}\right]^{\frac{1}{r}} \quad (14)$$

with the exponent $r \neq 0$. Calculating the limit as r approaches 0, we get the power means of order r in the form

$$M_r(a,b)=\begin{cases}\left[\dfrac{a^r+b^r}{2}\right]^{\frac{1}{r}} & , \quad r\neq 0\\ \sqrt{ab} & , \quad r=0\end{cases}. \quad (15)$$

The known members of the mean mean collection M_r are harmonic mean $H=M_{-1}$, geometric mean $G=M_0$, and arithmetic mean $A=M_1$.

Now take different positive numbers a and b, and consider the integral mean

$$M^{\text{int}}_{\varphi(x)=x^{r-1}}(a,b)=\left(\frac{1}{b-a}\int_a^b x^{r-1}dx\right)^{\frac{1}{r-1}}=\left[\frac{a^r-b^r}{r(a-b)}\right]^{\frac{1}{r-1}} \quad (16)$$

with the exponent $r\neq 0,1$. Calculating the limits as r approaches 0 and 1, and the limit as b approaches a, we get the generalized logarithmic means (see [3] and [4]) of order r as

$$L_r(a,b)=\begin{cases}\left[\dfrac{a^r-b^r}{r(a-b)}\right]^{\frac{1}{r-1}} & , r\neq 0,1\ ,\ a\neq b\\ \dfrac{a-b}{\ln a-\ln b} & , \ r=0\ ,\ a\neq b\\ \dfrac{1}{e}\left[\dfrac{a^a}{b^b}\right]^{\frac{1}{a-b}} & , \ r=1\ ,\ a\neq b\\ a & , \qquad a=b\end{cases}. \quad (17)$$

The important means of the collection L_r are geometric mean $G=L_{-1}$, logarithmic mean $L=L_0$, identric mean $I=L_1$, and arithmetic mean $A=L_2$.

Remark 3.1. 13 *The logarithmic and identric mean for different positive numbers a and b can be obtained by using integrals,*

$$L(a,b)=\left(\frac{1}{b-a}\int_a^b\frac{1}{x}dx\right)^{-1}=\frac{a-b}{\ln a-\ln b} \quad (18)$$

and

$$I(a,b)=\exp\left(\frac{1}{b-a}\int_a^b\ln x\,dx\right)=\frac{1}{e}\left[\frac{a^a}{b^b}\right]^{\frac{1}{a-b}}. \quad (19)$$

Assume that $0<a<b$. Relying on Theorem A, we can prove that the mean functions $r\mapsto M_r(a,b)$ and $r\mapsto L_r(a,b)$ are strictly increasing on the whole domain R, having the limit value a at negative infinity, and b at positive infinity. So, these two mean functions are continuous bijections of R to (a,b).

Applying the convexity and concavity of the power function $f(x)=x^{r-1}$ to the Hermite-Hadamard inequality, we can determine the mutual order of power and logarithmic means.

Theorem 3.2. 14 *If $0<a<b$ and $r<2<s$, then we have the series of inequalities*

$$a<M_{r-1}(a,b)<L_r(a,b)<A(a,b)<L_s(a,b)<M_{s-1}(a,b)<b. \quad (20)$$

Proof of Theorem 3.2. Taking into account what has been said above, we need to prove the inequalities $M_{r-1}(a,b)<L_r(a,b)<A(a,b)$ and $A(a,b)<L_s(a,b)<M_{s-1}(a,b)$. Prove the inequality referring to r by using the power function $f(x)=x^{r-1}$ in the cases $r<1$ and $1<r<2$. If $r=1$, the accompanying inequality $M_0(a,b)<L_1(a,b)<A(a,b)$ holds.

If $r<1$, then applying the Hermite-Hadamard's inequality to the strictly convex function f on the interval $[a,b]$, we get

$$\left[\frac{a+b}{2}\right]^{r-1}<\frac{a^r-b^r}{r(a-b)}<\frac{a^{r-1}+b^{r-1}}{2}, \quad (21)$$

and raising to the negative power $1/(r-1)$ yields $A(a,b)>L_r(a,b)>M_{r-1}(a,b)$.

If $1<r<2$, then applying the Hermite-Hadamard inequality to the strictly concave function f on $[a,b]$, we get the reverse inequality in equation (21), and raising to the positive power $1/(r-1)$ yields the required inequality. □

At the end of the section we present some mean inequalities. Let a and b be different positive numbers. With the well-known inequality

$$H(a,b)<G(a,b)<L(a,b)<I(a,b)<A(a,b), \quad (22)$$

we point out the following inequalities:

$$M_0(a,b)<L(a,b)<M_{1/3}(a,b) \quad (23)$$

$$M_{2/3}(a,b)<I(a,b)<M_{\ln 2}(a,b) \quad (24)$$

$$M_0^2(a,b) < L(a,b)I(a,b) < M_{1/2}^2(a,b) \quad (25)$$

$$I^{\frac{1}{2}}(a,b)G^{\frac{1}{2}}(a,b) < L(a,b) < \frac{1}{2}I(a,b) + \frac{1}{2}G(a,b) \quad (26)$$

4. Conclusion

The originator of the concept of entropy was German physicist Rudolf Clausius about half of the nineteenth century. He objected to the supposition that no change occurs in the working body, and gave this "change" a mathematical interpretation by questioning the nature of the inherent loss of usable heat when work is done, for example, heat produced by friction. Clausius described entropy as the transformation content, that is, dissipative energy use, of a thermodynamic system or working body of chemical species during a change of state. This was in contrast to earlier views, based on the theories of Isaac Newton, that heat was an indestructible particle that had mass.

Power and logarithmic means play an important role in representing and solving the problems of thermodynamics, quantum mechanics and information theory. In these direct applications, the aforementioned means are usually called entropies. For more details on connections between entropies and means, see [1].

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INTRUSION DETECTION SYSTEM WITH SENSOR NETWORKS

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Abstract

In this article an intrusion detection system is proposed to detect illegal entries into remote and hardly accessible protected areas. The goal of the research was to create an inexpensive, non-intrusive, easily deployable, energy-efficient anti-theft sensor network. Our solution contains magnetometers as sensors, supported by a fusion algorithm on the base station. With the proposed solution we are able to raise alarms when a vehicle is entering into the protected area and estimate its direction and speed. The sensors can detect vehicles at a distance of 3 meters. The detections are fused at the central base station and the operator is informed about the intrusion and its parameters. The paper describes the sensory solution, the fusion method, and real tests are used to evaluate the proposed solution.

Keywords:

Sensors, magnetometer, detection, fusion

1. Introduction

Vehicle detection systems are commonly used in various applications, e.g. traffic control, security systems, or intelligent parking systems. Several sensory technologies are used today for vehicle detection. These systems can be divided into two main groups: intrusive systems, which are deployed under the road surface, and non-intrusive systems, which allow deployment without any intrusion [1]. The most commonly used solutions are inductive loops, pneumatic tubes, and image processing systems.

In our solution an inexpensive, easily deployable sensor system is proposed, using magnetic sensors organized into a wireless network. The solution contains a high sensitivity magneto resistive sensor to provide high reliability. The sensors are deployed in groups to increase detection reliability, as shown in Figure 1.

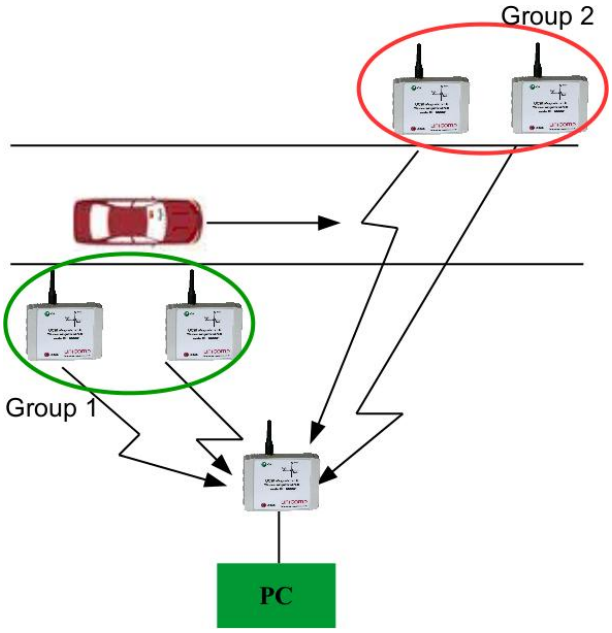

Figure 1. The proposed sensor network deployment scheme. In the example there are two sensor groups, each containing two sensors.

Every group contains a pair of magnetic sensors. Each sensor sends the detection to the base station, which is connected to a PC, to determine the properties of the passing-by vehicle.

In Section 2 the applied magnetic-based sensor technologies are reviewed. In Section 3 the sensor fusion is introduced. Measurements results are presented in Section 4. Section 5 concludes the paper.

2. Magnetic sensors

The magnetic-based solution contains a three-axis magneto-resistive magnetometer HMC1002 [2]. The sensors are made from a ferrous material, which changes its resistance when the magnetic field changes nearby. A Wheatstone-bridge is constructed from four magneto-resistive elements, and thus the change in the magnetic field can be detected as a change in the output voltage [2].

The output of the sensor is amplified in two stages, where the gain of the second amplifier can be set by a digital potentiometer, as shown in Figure 2.

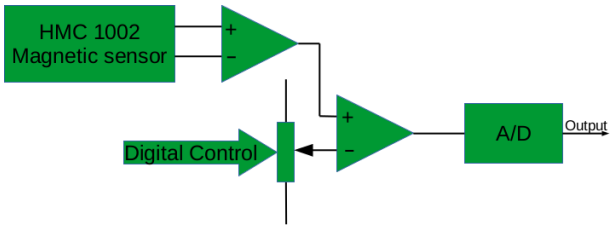

Figure 2. Magnetometer block diagram.

Because of the high sensitivity of the sensor the output signal is easily saturated, thus careful adjustment of the digital potentiometer is necessary to allow meaningful measurements. For this purpose an automatic compensation algorithm is proposed.

During the deployment phase the magnetic field changes rapidly; to allow fast start up of the device the compensation algorithm needs to react to such fast changes. During normal operation, however, the ambient magnetic field changes slowly; the compensation algorithm has to be able to deal with slow changes as well [3].

In the signal processing stage we used an exponential average block to provide a *fast average* of the raw signal. In Figure 3.a the raw sensor signal and its fast average is shown. In the next processing step the square of the difference of the raw signal and its fast average is calculated and filtered by a low-pass filter to create the quadratic mean as shown in Figure 3.b. A threshold is calculated from the *slow average* of the quadratic mean, also shown in Figure 3.b. Figure 3.c shows a situation when a detection occurs: the quadratic mean is higher than the threshold.

The measurement message contains the sensor identification number and a triplet: maximum amplitude *A*, the length of the detection *L* and the time of the detection *T*, as shown in Figure 3.c.The measurement message is sent by radio to the central fusion station.

3. Sensor Fusion

The detections are correlated in a PC connected to the base station using the triplet (*A, L, T*). Figure 4 shows the flowchart of the fusion. Whenever a detection message is received, the sensor fusion starts to operate. The algorithm maintains a reliability score which shows the reliability of an event detection, based on the current measurements. The higher the reliability index the higher the probability of the detection.

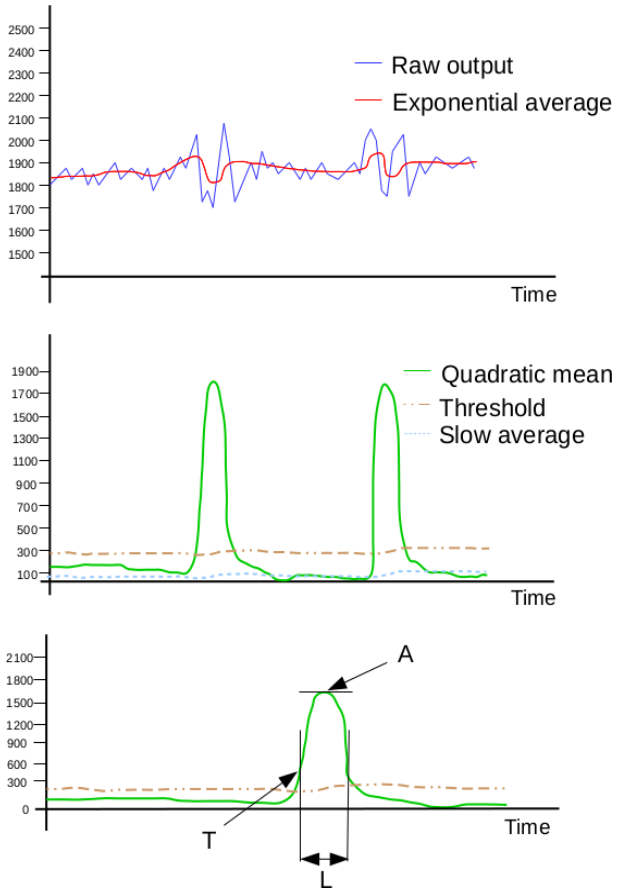

Figure 3. a, Raw measurenet and its exponential average
b, Quadratic mean, slow, average, and the threshold
c, properties of the detection.

In first step the detections are stored in the memory and the fusion compares the last received detections. If a possible match is found the *reliabilityScore* is increased. If the message came from another sensor group then the speed and direction estimation is possible. The speed (and direction) of the vehicle is estimated using the distance Δs between the two groups of sensors providing measurements, and the time difference Δt between the measurements as $\bar{v} = \Delta s / \Delta t$. When the *reliabilityScore* reaches the minimum requirement then an alarm is raised and send to the operator.

After each detection a *Timer* is started, which is used to age the stored measurements. If no detection arrives for the set time period (a few seconds) then old detections are purged from the memory and the reliability index is reset to zero. This way the fusion algorithm is able to distinguish between consecutive events happening after each other.

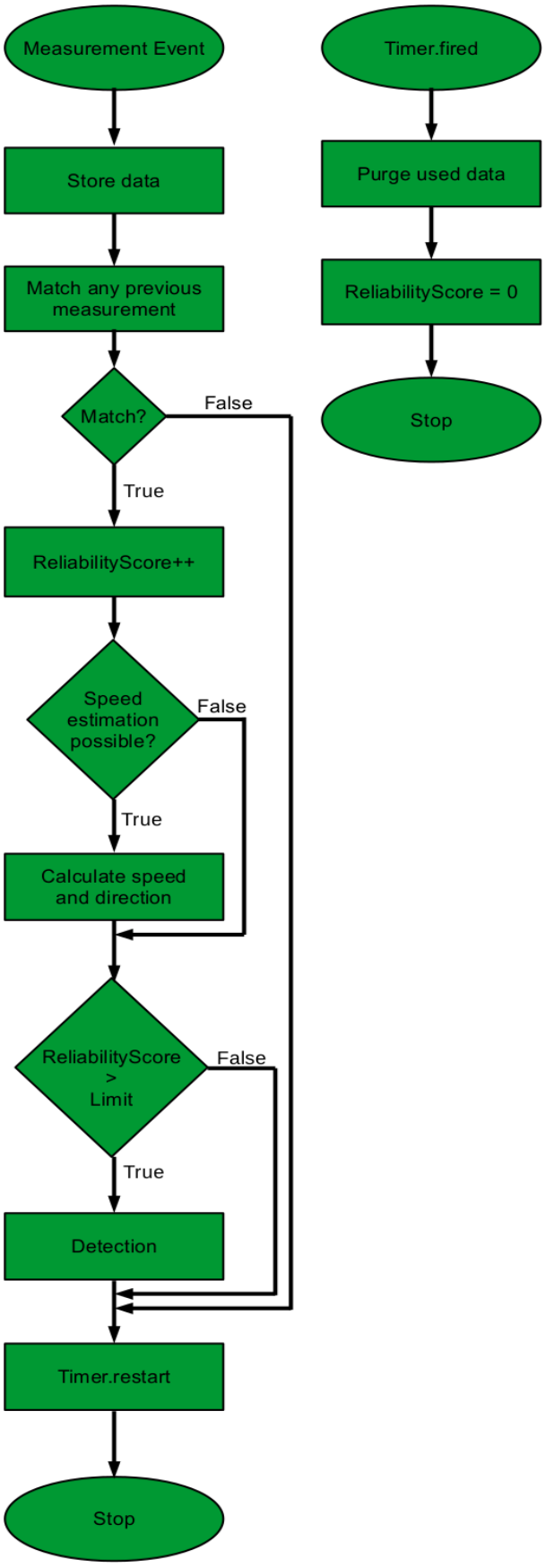

Figure 4. Flowchart of the fusion.

4. Test results

To test the performance of the sensor network we conducted several real-time tests. Figure 5 shows the setup of the test case: we placed three groups of sensors at a distance of 0.5 meter from the road. The individual groups were $\Delta s = 20$ meters from each other. A passenger vehicle was used in the tests. In the first tests the vehicle passed by the sensor field from the right then turned back and passed by sensor field again from the left.

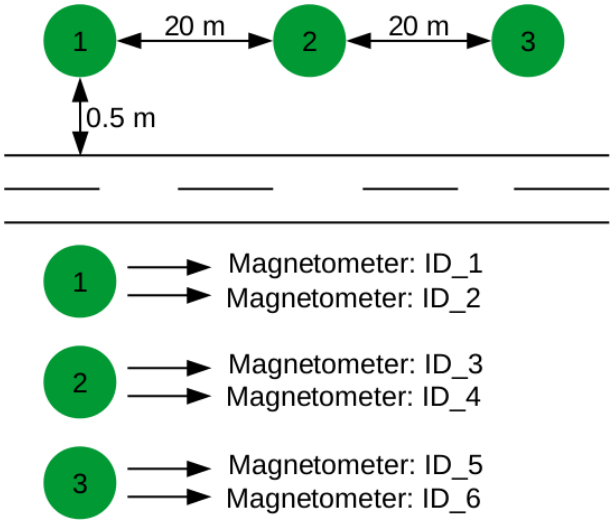

Figure 5. Measurement sensor setup using three groups of sensors, each group containing two sensors.

The results are summarized in Figure 6, where the sensor detections are denoted by stars. The exact times of detections $(t_1, t_2, \ldots, t_6)$ are also shown on the top of the figure. From the measurements it is clear that the vehicle came twice through the network, first from the right side to the left side and the second time from the opposite direction.

As detections arrived the fusion algorithm calculated the *reliabilityScore* as shown in Figure 6. In the example in both directions all of the sensors detected the vehicle thus in each case the *reliabilityScore* was 6. Note that because of the time gap between the two events the algorithm reset the reliability index and detected two separate events, both with high (6) reliability.

The speed estimation uses the timestamps of the received messages. When more detections from a group are available, the average of the detection times in the group is calculated. The speed estimation uses timestamps (or average of timestamps) from two different sensor groups. The speed estimation process for the measurement of Figure 6 is illustrated in Figure 7, for the first round of the vehicle (driving from right to left). The algorithm calculated the estimated speed between the first and second group as 14 km/h and between the second and third groups as 9 km/h.

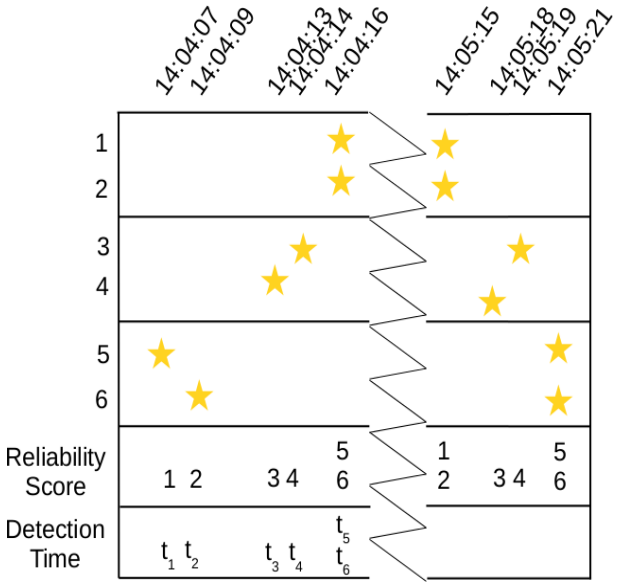

Figure 6. Detections in a real test with a vehicle passing by the sensor field twice in two different directions.

The first column of Figure 7 indicates the IDs of sensors providing detections, in the order shown in Figure 6. The detecting sensors are also indicated by a star in column two Column three illustrates the computations of Δt: when possible, the average detection time from a group is used. Notation $(\overline{t_i, t_j})$ means the average time $(t_i+t_j)/2$. In the tests $\Delta s = 20m$ was used between the consecutive groups. The true speed of the vehicle was approximately 10 km/h which is reasonably well estimated by the network. The accuracy of the speed estimation could be increased with larger distances between the sensor groups, thus the effect of uncertainty in time measurements can be decreased.

To evaluate the performance of the system ten rounds were measured and analyzed with different speeds (10 km/h - 30 km/h), directions (left-to-right, right-to-left), and sensor distances from the road (0.5m - 3m). The results are shown in Figure 8. The table contains the number of sensors deployed in the sensor field *NoS*, the achieved *reliabilityScore RS*, the estimated speed $\bar{v}$, and the real speed v.

ID	Detections	Δt	$\bar{v}$ km/h
5	– – – – ★ –	–	–
6	– – – – – ★	–	–
4	– – – ★ – –	$t_3-(\overline{t_1,t_2})$	14.4
3	– – ★ – – –	$(\overline{t_3,t_4})-(\overline{t_1,t_2})$	13
1	– ★ – – – –	$t_5-(\overline{t_3,t_4})$	9
2	★ – – – – –	$(\overline{t_5,t_6})-(\overline{t_3,t_4})$	9

Figure 7. Speed estimation process for a vehicle passing by the sensor field.

The *reliabilityScore* was between 5 and 6 in each case, indicating that the sensors can detect vehicles with good reliability. Note that the *reliabilityScore* of 3 indicates an event with high probability, scores higher than this indicate an event with very high probability. The speed estimators are reasonable but has large variance, which is due to the relatively small distance between sensor groups.

	NoS	RS	$\bar{v}$ (km/h)	v real (km/h)
1.	6	5	9.6	10
2.	6	5	9	10
3.	6	5	14.4	20
4.	6	6	14.4	20
5.	6	6	16	30
6.	6	5	24	30
7.	6	5	12	30
8.	6	5	13	30
9.	6	5	16	20
10.	6	6	14.4	20

Figure 8. Speed estimation results of ten vehicles passing by the sensor field.

5. Conclusion

An easily deployable sensor network was proposed which is able to detect passing by vehicles from the distance of 0.5-3 meters. Using groups of sensors the fusion algorithm is able to provide robust estimation of the presence of the vehicle and the direction and speed of the vehicle can also be estimated. The sensor networks can be placed near the road without intrusion.

Acknowledgement

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OMNIDIRECTIONAL CAMERA CALIBRATION

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Abstract
The omnidirectional camera is an optical device which can capture images in 360 degrees field of view. We developed a 3D camera system using multiple omnidirectional cameras, which will be used as a car mounted camera system.
In this article we discuss the design, construction and calibration of omnidirectional cameras. We present the used camera model that allows us to use an omnidirectional camera as a perspective camera, and the distortion model, that is suitable to correct precision problems of the assembly process.

Keywords:
Computer vision, omnidirectional camera, camera calibration

1. Introduction

Observing the space around a moving car is a challenging problem, which often requires untraditional equipment. Existing systems often use RADAR or LIDAR technologies to scan the surrounding, but using visual sensors still have some benefits. Apart from being considerably cheaper, the visual signal can hold more details, and can be processed rapidly with the current computer technologies. The most important advantage is that the color property of the objects provide more information for identification than the 3D shape alone. Road signs, lane border marks, or pedestrian crossings can only be recognized from visual signal. Also, detecting and tracking moving objects is more feasible using the image of objects then from a limited 3D point set of the objects alone.
These advantages more than compensate the obvious drawback of visual signals, namely that there are driving conditions when they are mostly missing, e.g. during the night or in a fog. However, these conditions are also inconvenient for the human drivers, who need to change their driving style under these conditions, and are also forced to increase their visual range, which would in turn benefit the visual assistant system.
As a result many existing driver assistant systems utilize cameras, mostly to observe the space in front of the car [10].
Our goal is to address the problem of observing the space around a car in 360 degrees field of view using visual methods. This has been done before using omnidirectional cameras [9] or large field of view cameras [8].
Our novelty is that we apply multiple omnidirectional cameras that can provide stereo (and mostly also multi–view) image data in every direction. From this multi-view data it is possible to reconstruct 3D properties, while still having access to the color properties of the objects (thus combining the advantage of RADAR, or LIDAR systems with large field of view visual sensors).
Our system contain three omnidirectional cameras on top of the car and two conventional cameras observing the front of the car in larger detail. Figure 1 shows a frame from a 200 frame recorded video sequence.

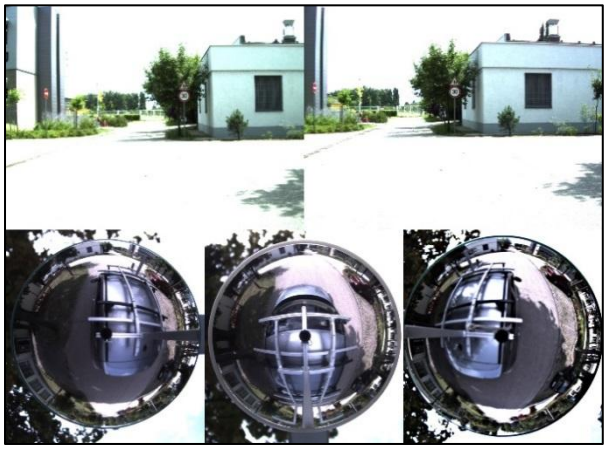

Figure 1. A frame from a 200 frame sequence

The future goal is to develop a 3D camera system that can provide data for many practical research fields: recognizing road signs; lane borders; pedestrian crossings; to predict motion of moving objects around the car; detect pedestrians in danger zones; reduce blind spots and to reconstruct the 3D scene around the car.
Many of the above fields are based on 3D multi view reconstruction, which in turn requires that the camera system was calibrated. In this article we address the problem of calibration, with special focus on calibration of omnidirectional cameras. In Section 2 we discuss the used camera models and in Section 3 we present the calibration method suitable to calibrate the selected models. In Section 4 we summarize the calibration of a 3D

camera system, and the detected calibration errors are provided. In Section 5 we conclude and discuss the future work.

2. Camera models

We would like to use our camera system for reconstruction purposes. For this, the mapping of the recorded light rays of the 3D scene to the camera images has to been known. This mapping is based on the projection model of the camera system, with some unknown parameters that need to be determined during a calibration process.
The camera projection model is often divided into two parts.
The intrinsic camera parameters describe the projection of the 3D objects as viewed from the camera to the 2D image [5]. In case of a normal perspective camera (see Figure. 2. a,), the projection of a $\boldsymbol{X} = [x_w, y_w, z_w]^T$ 3D word point to $\boldsymbol{u_i} = [\boldsymbol{u}, \boldsymbol{v}, \boldsymbol{1}]^T$ homogenous image point on the image plane can be described with the following linear equation:

$$\boldsymbol{s u_i = K[R_c, t_c]X,} \qquad (1)$$

where $\boldsymbol{s}$ is a scaling factor, $\boldsymbol{K}$ is the intrinsic camera calibration matrix, $[\boldsymbol{R_c}, \boldsymbol{t_c}]$ are the extrinsic calibration parameters. The 3x3 $\boldsymbol{K}$ matrix hold the focal length, aspect and principal point of the camera as described in [5].
In case of omnidirectional camera the projection cannot be described with linear equation and more additional parameters are needed.
Our omnidirectional camera consists of a hyperboloid mirror and a normal perspective camera (see Figure. 2. b,) [2]. The mirror surface can be described with the equation:

$$\frac{\boldsymbol{x^2}}{\boldsymbol{a^2}} - \frac{\boldsymbol{y^2}}{\boldsymbol{b^2}} = \boldsymbol{1,} \qquad (2)$$

where a and b are the main parameters of the hyperbola.
Suppose that we are observing a scene point $\boldsymbol{X}$ by an omnidirectional camera. The ray, which come from $\boldsymbol{X}$ and go the direction of the mirror center (O_m), reflected by the mirror at point $\boldsymbol{X}_m = [x_m, y_m, z_m]^T$. This ray goes through the external focal point of the hyperboloid (O_c). If we place a normal perspective camera into O_c it can project the ray to point $\boldsymbol{u_i}$ on its image plane.
The projection of the internal camera (O_c) (from $\boldsymbol{X}_m$.to $\boldsymbol{u_i}$) can be described by equation (1). But the mapping of point $\boldsymbol{X}$ to point $\boldsymbol{X}_m$.cannot be described by a linear equation. To formalize the projection the following equation (2) should be solved:

$$\boldsymbol{\lambda^2}\left(\frac{\boldsymbol{{z_w}^2}}{\boldsymbol{l^2 a^2}} - \frac{\boldsymbol{1}}{\boldsymbol{b^2}}\right) + \boldsymbol{\lambda}\left(\frac{\boldsymbol{\frac{2z_w}{b^2}(b^2+l)}}{\boldsymbol{a^2}}\right) = \boldsymbol{1,} \qquad (3)$$

where a and b describe the shape of the mirror as in (2) and $l = \sqrt{a^2 + b^2}$. Using the solutions $\lambda_{1,2}$ the intersection points on the mirror computed as $\boldsymbol{X}_m = [\frac{x_w\lambda_{1,2}}{l}, \frac{y_w\lambda_{1,2}}{l}, \frac{z_w\lambda_{1,2}}{l}]^T$ [3][6].

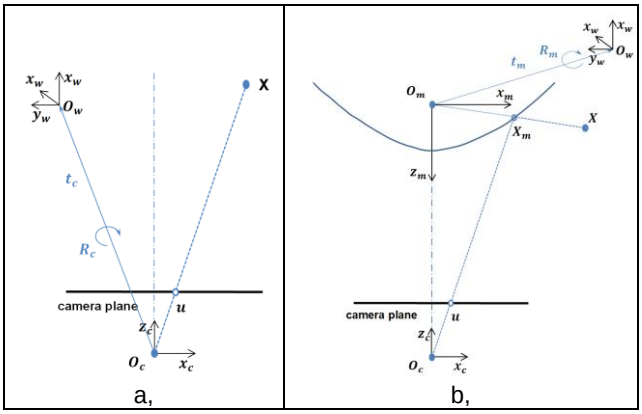

Figure 2. a, Perspective camera model, b, Omnidirectional camera with hyperbolic mirror

In summary, the intrinsic parameters of a hyperboloid omnidirectional camera are the intrinsic parameters of the internal perspective camera, the distance between the camera and the mirror, and the shape of the mirror (*a, b*).

The extrinsic camera parameters (*t, R*) describe the camera position and orientation in the word coordinate system (see Figure. 2. a, b,). These parameters are essential in multi camera systems [4].
The projection center of a normal perspective camera is the O_c focal point. The position (*t*, 3x1 vector) and the orientation (*R*, 3x3 rotation matrix) store all the missing parameters for the projection described in equation (1).
In case of an omnidirectional camera we chose the center of the mirror O_m as the projection center, since all light rays recorded by the camera pass through that point. With this model, the extrinsic parameters of the omnidirectional camera are identical to that of the perspective camera: a *t* position vector and an *R* rotation vector of the focal point.

3. Calibration

During the camera calibration process the projection parameters use in equation (1) and (3) are estimated. Usually the process consists of two main steps.
The intrinsic calibration step is well known in case of perspective cameras. A known 2D structure is moved in front of the camera and together with the detected structure equations can be formalized to constrain parameters of matrix $\boldsymbol{K}$.
Zhang's method [7] is a popular solution to this problem. This method estimates intrinsic camera parameters using images from black and white

planar chessboard pattern (see Figure 3.). Taking pictures from 30-50 different views of the pattern lead to a good calibration result.

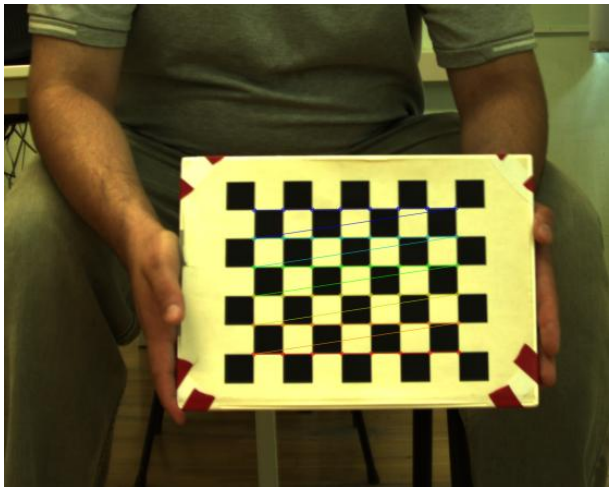

Figure 3. Intrinsic calibration with chessboard pattern

In case of an omnidirectional camera, the model contains an inner conventional perspective camera and a hyperboloid mirror [1].
The inner camera can be calibrated like a normal perspective camera. This step is performed before the mirror and the camera are assembled. The parameters of the hyperboloid mirror can be measured during or after manufacturing using non-visual means (see Section 4 for an alternative). Together with the inner camera intrinsic parameters, the parameters (a, b) of the hyperboloid are all that is needed to perform a projection from the 3D world. If the internal camera is in the focal point and its image is rectilinear, then according to section 2, for every ray passing through the internal camera center, there is a ray passing through the focal point of the hyperboloid mirror. If the internal camera is calibrated (i.e. for each image point we know the light ray passing through its center), these corresponding external rays can be calculated using (3) and no other calibration is needed.
It must be noted however, that to use our model, the following assumptions must be true:

1. the shape of the mirror to be perfectly hyperboloid
2. the inner camera must be positioned exactly in the external focal point.

These presumptions must be considered during camera assembly, and we will address these issues in section 4.

The extrinsic calibration step is performed by detecting 2D image points of corresponding pre-known 3D word points. The relative position (t) and orientation (R) of the cameras to a fixed point (usually selected as one of the camera centers) are estimated solving a least squares problem [4].

It is important that the calibrating 3D world points must be visible from multiple cameras, and there must enough 3D points to over determine all camera extrinsic parameters.
Since the goal of this calibration step is the same for both types of cameras, we would like to use the same estimation method for both types. Unfortunately the estimation method exploits that the 3D points were projected by a linear projection matrix to a 2D image plane and the omnidirectional camera images are not the images of a perspective camera. To address this problem, we form a virtual perspective camera in the center of the mirror (O_m) (see Figure 4.) and project the mirror points ($\boldsymbol{X}_m$) to a virtual plane (points $\boldsymbol{u}_v$).

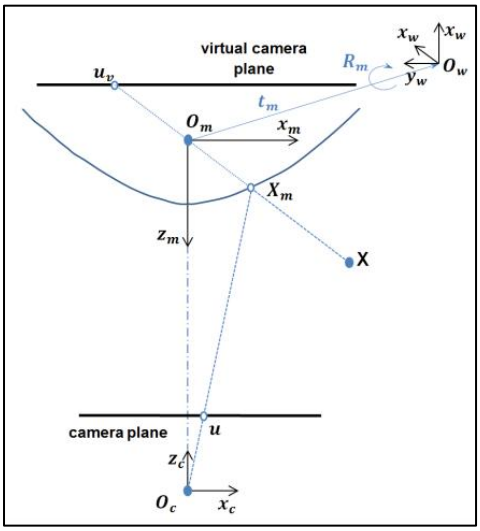

Figure 4. Forming a virtual perspective camera

The intrinsic parameters of the virtual camera can be arbitrarily selected (e.g. the identity matrix is a suitable for matrix $\boldsymbol{K}$)
Projecting all detected 2D points to the virtual plane, the standard estimation method is applicable.

4. Application and evaluation

In Section 1 we introduced a 5 camera car mounted camera system using 2 normal and 3 omnidirectional cameras. Our intention was to calibrate this system to a fixed world coordinate system.
As a first step, we fixed the focus of all optics, and performed intrinsic calibration for all cameras as described in section 3. After this, we fixed the positions of mirrors and normal cameras in the camera system. The relative positioning of the internal cameras of the omnidirectional cameras was done as the final step of the assembly.
To complete the internal calibration of the omnidirectional cameras, we have to learn the parameters of the hyperbola and we have to confirm that the two assumptions used in our model (described in Section 3) are true. The

parameters (a , b) were measured and assumption 1 (the mirror is indeed hyperboloid) was verified using a Mitutoyo contour measuring device.
Assumption 2 (the camera is in the external focal point of the hyperboloid) was assured during assembly using a software tool, described below.
We exploited the following facts:

1. the image of the camera optics is visible around the principal point of the camera only if the camera axis is locally perpendicular to the mirror surface.
2. the mirror was manufactured such, that the hyperboloid was cut off using a perpendicular plane to the rotation axis, making the border of the mirror a perfect circle.
3. Under perspective projection, the image of a circle can only be a co-centric circle if the image plane is parallel with the circle and the camera axis passes through the circle center.
4. knowing both the diameter of the mirror and the calibration data of the internal camera, the image of the mirror border must be of known size on the image.

Based on these facts we developed a software that locates the image of the camera optics and detects the mirror border. Verifies the circularity and size and of the border we can assure that the camera is in the external focal point of the hyperboloid (see Figure 5.).

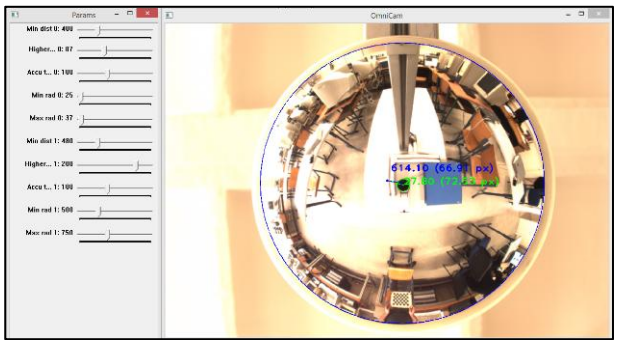

Figure 5. Camera positioning tool used during the assembly process

The camera system assembled, and intrinsically calibrated, we could perform the external calibration process.
We selected an external reference coordinate system: the coordinate system of an industrial ABB robot. We used a light source, positioned by the robot to mark 3D points in its own word coordinate system. On the camera images the points are detected (see Figure 6.).

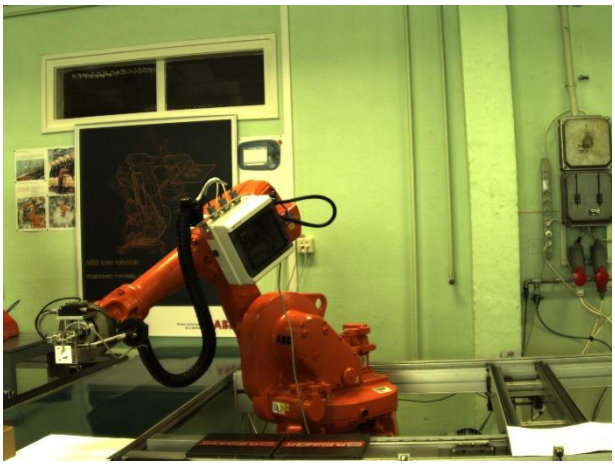

Figure 6. A light source held by an industrial robot

Using the known 3D coordinates from the robot coordinate system and the detected image points on all images, the external calibration method described in section 3 could be applied.
To verify the method in section 3, we need to measure the accuracy of the calibration of the camera system. There are more ways to do that, but the most informative is when we reconstruct 2D calibration points, and measure their distance from their corresponding 3D point in 3D space using Euclidean distance. The advantage of this method is that the results can be acquired in millimeters, and as such it is more meaningful. The drawback is that we apply the calibration data multiple times and the triangulation error is also incorporated to the measured error. Nevertheless, in practice this error estimates the error of the calibration reliably. We received the following results using 50 calibration points for the normal and the omnidirectional cameras.

Table 1. Calibration results

Cameras	**Average reprojection error [mm]**
Perspective cam #1	1.19
Perspective cam #2	1.21
Omnidirectional #1	20.62
Omnidirectional #2	8.43
Omnidirectional #3	16.95

As can be seen on Table 1, the normal cameras were calibrated with close to 1 mm accuracy, while the accuracy of the omnidirectional cameras can be measured in cm-s. This error can be contributed mostly to the limited resolution of the active regions of the omnidirectional cameras; the inaccuracies of the assembly process, the short baseline and the non-point like image of the calibration light blob.
Since the camera system was approximately 4 meters away from the robot, we can extrapolate that at the interesting 10 – 20 m range the

accuracy will fall to 5-10 cm and below, due to the bad baseline-object ratio. This accuracy is presumably enough for detecting static objects, but for moving cars, where the relative movement of the cars between frames can be below 1m, the adequateness requires additional evaluation.

5. Conclusion and future work

In this article we introduced the setup of a car mounted 3D camera system using multiple omnidirectional cameras. We presented the camera model of both perspective and omnidirectional cameras and provided intrinsic and extrinsic calibration methods for both models. We demonstrated the calibration steps of real cameras and measured the calibration accuracy. While the current accuracy is limited due to several factors, this method is applicable for a range of applications, mostly for detecting static objects.
As future work, we need to determine the minimum required accuracy for moving objects, to determine the adequateness of these calibration results.
To improve the accuracy we need to refine the model and consider both inner camera misalignment and the errors of the mirror surface. Along with the refined model we need to find a calibration method that can measure these new parameters reliably.

Acknowledgement

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GPS BASED VEHICLE TRAJECTORY PREDICTION AND ERROR ANALYSIS

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Abstract
One of the most effective ways to make traffic safer is to improve the efficiency of driver assistant systems. Positioning systems, as an important part of driver assistance systems, can be used to predict the future trajectory of a vehicle. Applications, such as collision prevention, are possible using vehicle-to-vehicle (V2V) communication systems, where the predicted trajectories of the vehicles are sent to nearby cars. The present paper investigates the error of GPS based linear and nonlinear trajectory prediction methods. The analysis shows how the prediction error depends on the shape of trajectory, prediction distance and the number of past samples used for estimation. The measurements were established using an embedded vehicle control system "smarty" developed by our research team. As a result a GPS based positioning and vehicle trajectory prediction module has been developed as a part of an intelligent driver assistant system.

Keywords:
Trajectory prediction, global positioning system (GPS), driver assistance systems, intelligent transportation systems

1. Introduction

Communication opens up new ways towards the development of cooperative services in the field of driver assistant systems [1], [2]. One potential application can be the forecasting of risky situations based on GPS coordinates and motion of nearby vehicles. The driving assistant can send alert signals to own and nearby drivers obtaining predicted trajectories of adjacent vehicles using V2V communication. In the literature [6-11] one can find a lot of candidate approaches for trajectory prediction such as
GPS coordinate positions,
Motion model of the vehicle: e.g. Constant Yaw Rate* and Acceleration model,
Maneuver recognition systems (knowledge database containing learned trajectories of typical maneuvers),
GIS - Geographical Information System: maps, including streets maps, roads, obstacles,
Turn indicator, driver's eye movements (it can predict intention of turn or lane change);
Desired route fed into a GPS navigator (the direction of pass on can be estimated with high probability in a crossing)
or any mixture of these methods (*yaw-rate is the vehicle's angular velocity around its vertical axis).
This paper concerns with GPS-based trajectory prediction, because of our embedded control system has the ability to obtain 5 Hz GPS position data. Barrios et al. [3] and Han-Shue Tan et al [4] investigate the option of using global positioning system (GPS). The results show that the main bottlenecks of GPS based trajectory prediction are accuracy, latency, and reliability. Although the details of the requirements also depend on the specific configurations and implementations of other modules in a system, the following requirements must be considered:
1) Accuracy: The positioning system should at least be able to distinguish between lanes. Since most lane widths are within 3–4 m, the vehicle position should be measured with an error of within 1 m.
2) Latency and bandwidth: The timing and update rate of sensors and signal processing should be fast enough compared to vehicle dynamics (typically below 2–3 Hz). Trajectory estimation can be based on the average human reaction time of 1.5 s to stop a vehicle. The reaction time and the time needed to stop the vehicle inevitably depends on the speed and the type of the vehicle, road and weather conditions.
3) Reliability and availability: The positioning system should be able to provide accurate positioning information under all normal operational conditions and locations. As a minimum a clear indication has to be given in the case of GPS outages.
This paper addresses these questions considering a conventional GPS receiver and a real time embedded vehicle controller equipped by collision alert software. The analysis has been shown that GPS position data can satisfy the accuracy requirement in special case. As a result, in order to establish a robust driver assistant application sophisticated signal processing and sensor fusion techniques has to be added such as
Kalman-Filter

motion model
map-matching techniques
Differential Global Positioning System (DGPS).

2. Trajectory prediction model

However it is known that GPS data may suffer from errors [5] coming from different sources such as the inaccuracy of satellite positions, orbital fluctuation, multipath, relativistic and atmospheric effects, clock and rounding inaccuracies, our purpose is to analyze the performance of pure GPS based trajectory prediction. As a prediction tool we applied polynomial fitting on past known samples. The prediction was carried out for latitudinal and longitudinal coordinates separately (while the elevation data was omitted for the sake of simplicity). First and second order polynomial fitting (i.e. linear and quadratic least squares fitting) was compared on a basis of the number of past samples used for prediction (see Figure 1.). Let *N* be the number of past samples used to fit and *M* be the number of predicted points. The prediction functions for every $t = N+1, N+2, \dots, N+M$ are:

$$y_{predicted\ linear}(t) = c_0 + c_1 t$$

$$y_{predicted\ quadratic}(t) = c_0 + c_1 t + c_2 t^2$$

The goal is to minimize the square error (ε) between the measured and predicted points:

$$\varepsilon = \sum_{i=1}^{N} (y(i) - y_{predicted}(i))^2$$

$$Linear: \min_{c_0,c_1} \varepsilon \quad Quadratic: \min_{c_0,c_1,c_2} \varepsilon$$

In this case the formulae to find the coefficients $c_{j,opt}$ (linear: j = {0,1}; quadratic: j = {0,1,2}) are:

$$\sum_{i=0}^{1} c_i \sum_{k=1}^{N} t_k^{i+j} = \sum_{k=1}^{N} y_k t_k^j \qquad (1)$$

$$\sum_{i=0}^{2} c_i \sum_{k=1}^{N} t_k^{i+j} = \sum_{k=1}^{N} y_k t_k^j \qquad (2)$$

where c_0, c_1, c_2 are the coefficients of the systems of linear equations, and past sample coordinates are measured in time instants $t_1, t_2, \dots, t_N$ with $y_1, y_2, \dots, y_N$ values.

3. "Smarty" embedded system utilizing trajectory prediction

The embedded module "smarty" (Figure 2.) was designed by our research group to be used in a vehicle to serve as a driver assistance system. It was programmed in ANSI-C under ChibiOS/RT Real Time Operating System. The hardware is built around the STM3F407 32 bit MCU which has an FPU unit and runs DSP commands as well. Functional blocks are: GPS data receiver, wireless communication module (WLAN), Real Time Clock, analogue 3-axis accelerometer and yaw-rate sensors, Temperature and humidity sensor.

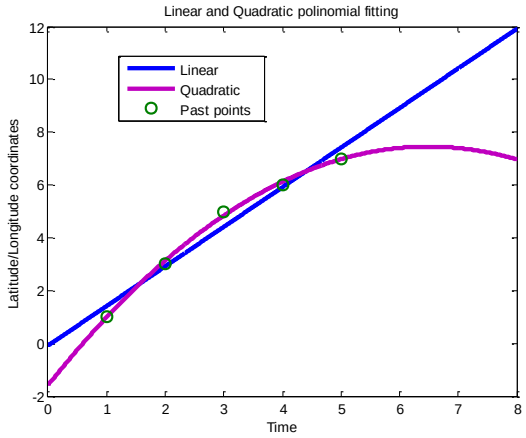

Figure 1. Linear and quadratic polynomial fitting

The software of the smarty is built on a tasks system (implemented as static threads in ChibiOS) with functionally separated state machines.

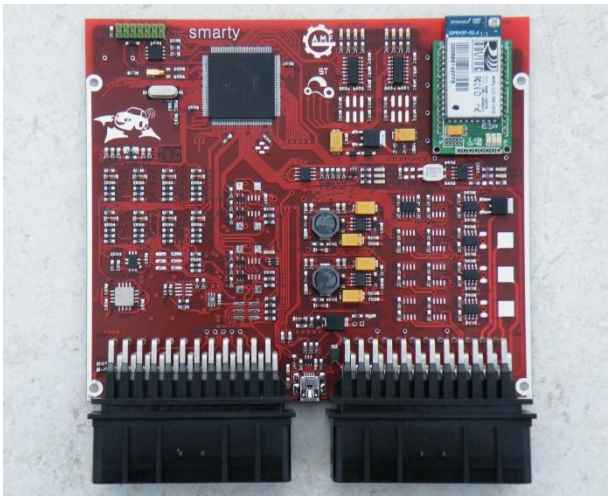

Figure 2. "Smarty" embedded system

A separated visualization and diagnostic tool has been developed in .NET for PC, which can acquire the packages shared by the Smartys, and were used in this paper to evaluate and analyze the result of predictions in real routes (Figure 3).

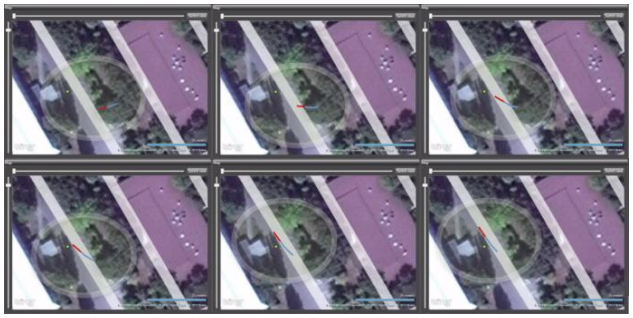

Figure 3. Result of predictions in real routes

4. Error analysis

This paper aims to detect the dependency of the prediction error – in the case of prediction model (1) and (2) – from the shape of real trajectory and number of past samples used for prediction. In order to obtain these results two trajectories were used during the measurements: a near straight and a circular one for testing near constant flex. As a result the following scenarios were analyzed:
Straight path, linear fitting,
Straight path, quadratic fitting,
Circular path, linear fitting,
Circular path, quadratic fitting,
Measurements were conducted in a car equipped with a "smarty" embedded controller and a Garmin GPS18x 5Hz receiver. Straight path was driven via an East-West direction (Figure 4) and circular path on a closed road segment (see Figure 5).
The prediction error highly depends on the prediction distance (i.e. the time distance between the current timeslot and the timeslot of the target of prediction); hence, prediction distance is also an important issue in our analysis.

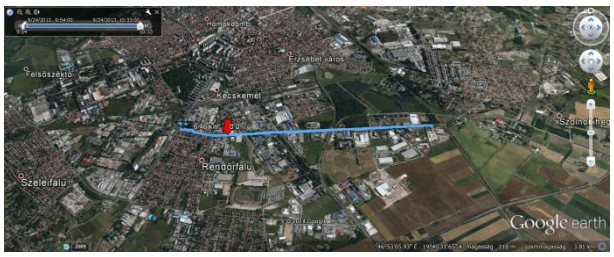

Figure 4. Straight path

Figure 5. Circular path

4.1. Straight path, linear fitting

As a reference we have investigated the simplest case: straight path, linear fitting. The results on absolute mean and maximum error for latitude coordinates are depicted on Figure 6. by solid and dashed lines, respectively. One can deduce from the curves that the mean error only slightly depends on both the number of past samples and prediction distance. The mean error is between 3-4 meters in the case of 3 seconds of prediction distance (which is twice the human reaction time). The value of the maximum error is very high (12-17m). The origin of these large values is the turn backs at the end of the session.
On Figure 7. the longitude prediction error can be seen. Here the best is to use 7 past points for the linear fitting which gives 1.16 meters error in average and 13.22 meters maximum error for 3 seconds of prediction distance. The average error is much smaller in the longitude (east-west) direction, since the road is also east-west, hence in the north-south (latitude) direction there is only measurement noise to which fitting is not effective.
Figure 8 depicts the mean Euclidean distance error as a function of the number of past samples and prediction distance in the case of straight trajectory and linear prediction. As a result for 3 seconds of prediction distance using 3 past samples (optimal number of past samples) one can obtain an average of 3.69 meters of Euclidean distance error. This value is higher than the desire of 1 m, so cannot be used for lane detection, however it can be useful for perpendicular collision alert applications.

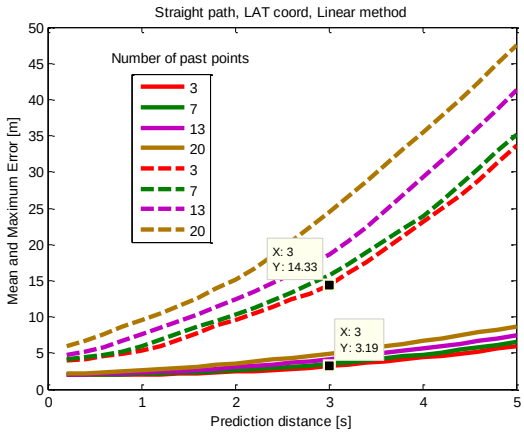

Figure 6. Straight path, Latitude coordinate, linear fitting (solid lines: mean error, dashed lines: maximum error)

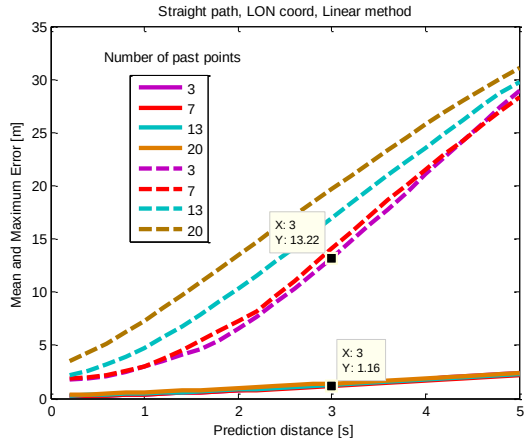

Figure 7. Straight path, Longitude coordinate, linear fitting

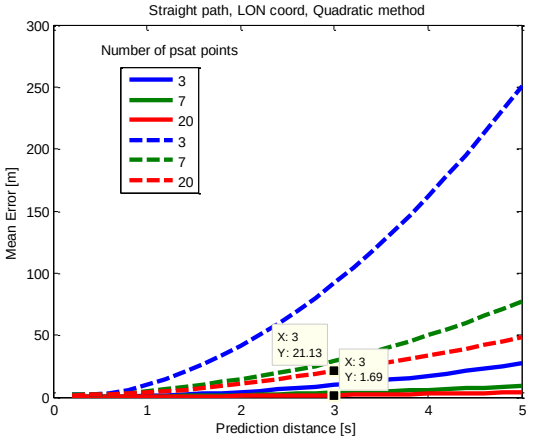

Figure 10. Straight path, Lon. c., Quadratic fitting

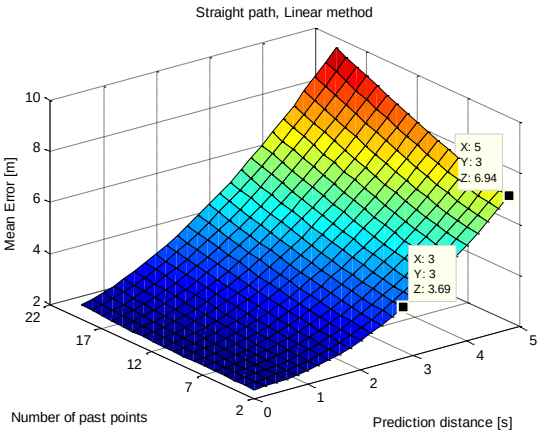

Figure 8. Mean error of Euclidean distance on straight path with linear fitting

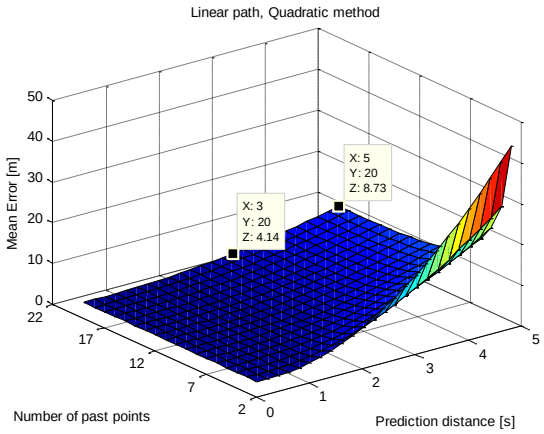

Figure 11. Mean error of Euclidean distance on straight path with quadratic fitting

4.2. Straight path, quadratic fit

Our preliminary hypothesis was that on straight path the quadratic fitting gives higher mean errors that the linear method. The results support our hypothesis as it depicted in Figure 9, 10 and 11, even in the case of small number of used past samples for fitting.

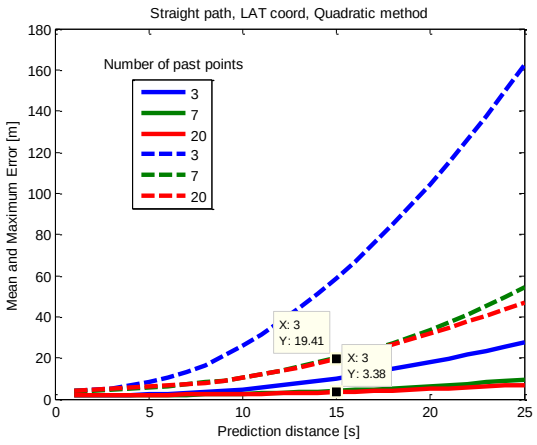

Figure 9. Straight path, Lat. c., Quadratic fitting

Using 20 past samples one can obtain only a slight performance degradation (3.38 meter error in latitude coordinates, 1.69 meters in longitude coordinates and 4.14 in Euclidean distance) related to the linear fitting (3 past points one can obtain an average of 3.69 meters of Euclidean distance error)

As a result, in the case of straight path linear fitting based on a few (3-5) past samples has been proven to be the most effective solution.

4.3. Circular path, linear and quadratic fit

In the case of circular path, nonlinear fitting comes to the fore. These subsection deals with the investigation of the difference between linear and quadratic polynomial fitting. In Figure 12, 13 and 14 one can see the absolute mean and maximum error of linear fitting method for latitude coordinates. Comparing to the results of quadratic polynomial fitting depicted on Figure 15, 16 and 17 one can highlight the fact that for shorter prediction distance (ca. 3 seconds) the quadratic method gives smaller error in average but it is worse in maximum error.

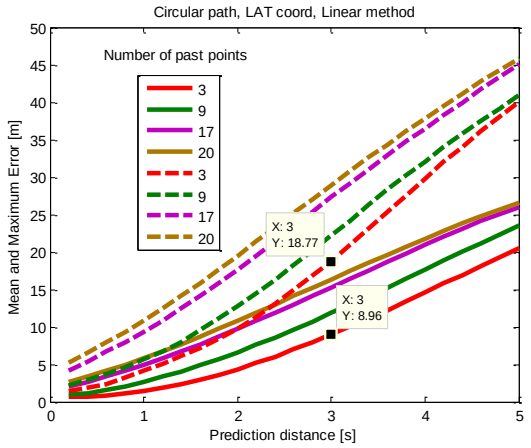

Figure 12. Circular path, Lat. c., Linear fitting

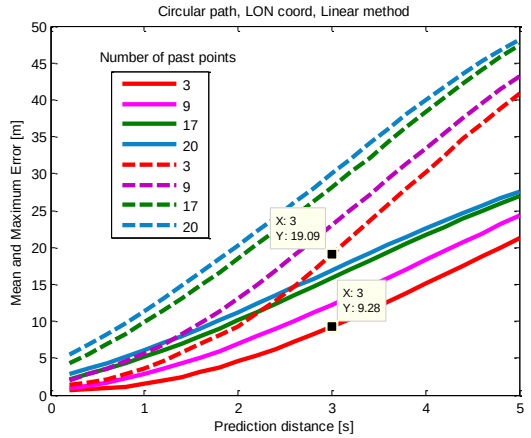

Figure 13. Circular path, Lon. c., Linear fitting

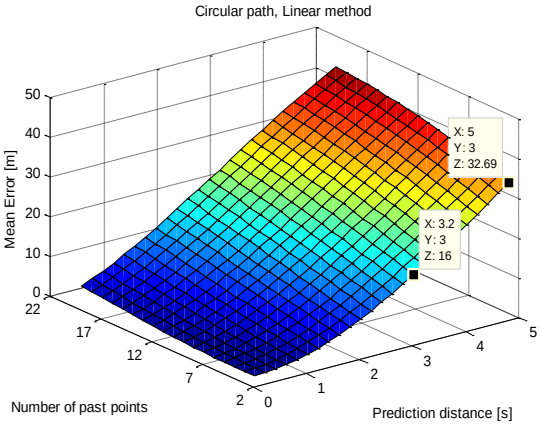

Figure 14. Mean error of Euclidean distance on circular path with linear fitting

For longer prediction distance (ca. 5 seconds) linear fitting gives better results than the quadratic one. The reason of this phenomenon is explained by Figure 18 (where the yellow line shows the past path while the predicted curves are drawn with white (20 past samples) and red colors (3 past samples)), where one can see that quadratic fitting for longer distances can be quite misleading, when one branch of the parabola is fit to a quasi linear session.

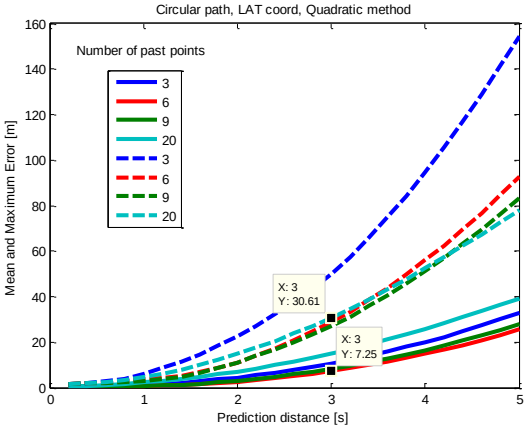

Figure 15. Circular path, Lat. c., Quadratic fitting

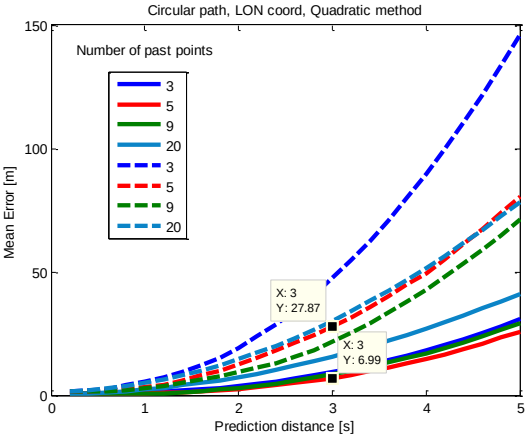

Figure 16. Circular path, Lon. c., Quadratic fitting

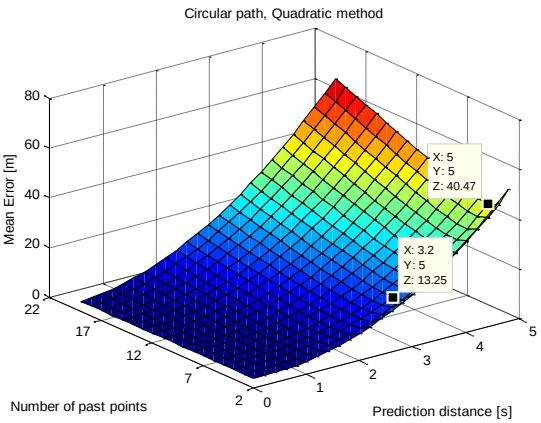

Figure 17. Mean error of Euclidean distance on circular path with quadratic fitting

5. Conclusion

In this paper the measurement-based performance analysis of GPS-based trajectory prediction error has been investigated. Both linear and quadratic polynomial fitting to past samples of a 5 Hz GPS receiver were analyzed as a function of the shape of the trajectory. The results demonstrate that

optimal number of past samples using to fit is very low (3 samples) in the case of linear fitting, and is about 5 samples for quadratic fitting
the average error increases near linearly with increasing prediction distance regardless the trajectory shape and method;
linear fitting leads to smaller average error when only a few (3-5) past samples are using for prediction.
quadratic fitting leads to smaller average error in the case of circular path in the case of 5-7 past samples;
the average absolute error in the case of 3 seconds prediction distance (about twice the reaction time of a driver) can be kept under 5 m using the methods described in this paper.

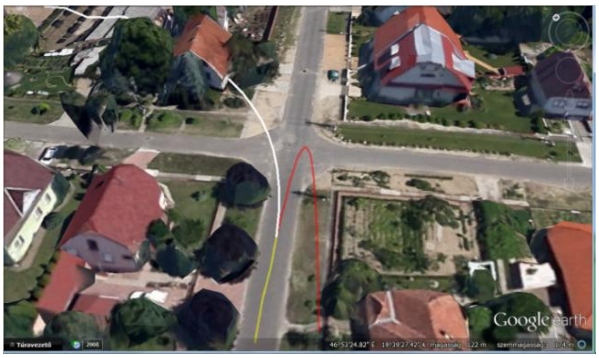

Figure 18. Error in prediction with quadratic polynomial fitting ahead a crossing

However the measured average absolute error is higher than required (1m), it can be enough for perpendicular collision alert applications.

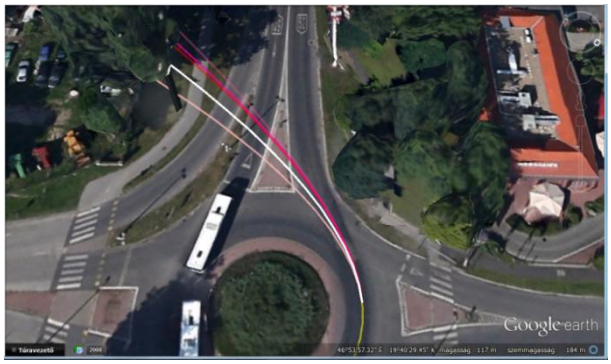

Figure 19. Prediction with quadratic polynomial fitting using different number of past points in a roundabout

The high value of maximum error can lead to too frequent false alarm. As a result, in order to establish a robust and enhanced quality of service solution to collision alert application additional sensor information (yaw-rate, acceleration, compass) should be incorporated, which is the target of future work.

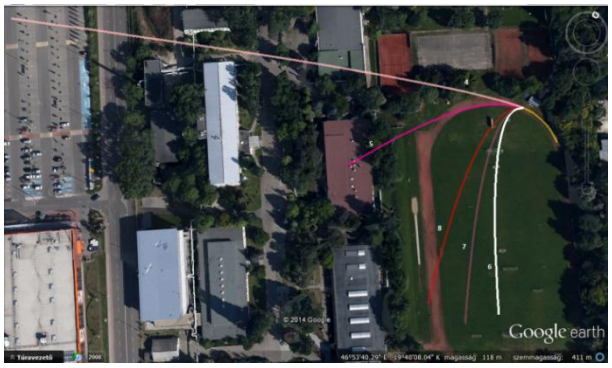

Figure 20. Prediction with quadratic polynomial fitting using different number of past points on a curved path

Acknowledgement
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AUTOMATIC LI-ION BATTERY TEST SYSTEM

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Abstract
A Li-ion battery test system is developed that is applied for charging and discharging battery cells meanwhile measuring the time-dependence of their properties. We concentrate on dynamical parameters like voltage drops between different charging-dicharging coarses, voltage and current falloff rates. The purpose of our work is to identify those easily measurable parameters of the battery that determine its state (state of charge, state of health, state of function).

Keywords:
Li-ion battery; automatic test system; state of health; state of charge; state of function.

1. Introduction

Li-ion batteries are featured by high energy density, high power density, long lifetime and environmental friendliness and thus have found wide applications in the area of consumer electronics. Though, automotive lithium-ion batteries have high capacity but are also coupled with such problems as safety, durability, and cost, imposes limitations on the wide applications of lithium-ion batteries in vehicles.

These batteries must be operated in a quite a limited safety margin of parameters [1]. Their temperature must not be too high or too low, it generally need to be in the 0-55 ^{o}C range. The operating voltage of lithium-ion cells is ususally between 1.5 and 4.2 V. Escaping from this safety margin of temperature and operating temperature can cause serious damage to the battery or even can cause fire or explosion [1].

Besides the safety issues the identification of the state of the lithium-ion cell is also a significant problem. There is a need for a good estimation of the state of charge (SOC), a state of health (SOH) and a state of function (SOF) of a lithium-ion cell in operation. SOC means the ratio of the remaining charge of the cell and the total charge while the battery is fully charged at the same specific standard condition. SOH means that the cell is how old, how much time remaind for it before one must take a new cell. Cells getting older its internal resistance getting higher and its capacity getting lower. The SOF is important when we want to know whether the cell can supply enough charge for a given task. SOF is determined by the aging factor, SOC range, temperature, and fault level.

Recently, a paper published on state of health estimation procedure that is based on some voltage drops between two different charging and discarging states of lithium-ion battery [2].

In this paper we report on our test system developed to investigate the measurable parameters of lithium-ion cells during their charging-discharging cycles. Our motivation is to map these parameters to compose a method by which one can estimate well the state of the lithium-ion cells in operation by measuring on the fly some easily measurable features of it.

2. Test system

We built a test system for measuring the voltage and the current of a cell that is charged, discharged many times at constant ambient temperature. In this way we can collect information on the change of behaviour of the cell as it gets older, that is as its state of health gets lower. We believe that the time dependence of these physical parameters at a given charging or discharging current levels supply information on the state of the cell.

An sbRIO embedded control and acquisition device was used to control the charging and discharging hardware. The overall system was controlled from a PC via a LabView-program (see Fig. 1.).

Figure 1. We apply LabView for controlling the testing hardwer

We use currently five mode of operations:

1. Simple charging process (T): It consists of two subprocesses, namely a constant current (TA) and a constant voltage (TV) subprocesses. (see Fig. 2.) During charging the voltage of the accumulator cell is increasing. It can not be charged above some specific voltage (depending on the type of the cell, the constant current value). To store as much charge as possible it is practical to continue the charging after the voltage reached the maximal allowable value with charging at constant voltage. Then the current value is decreasing in time. There must be given a minimal current value ($I_{\min}$) to stop this procedure.

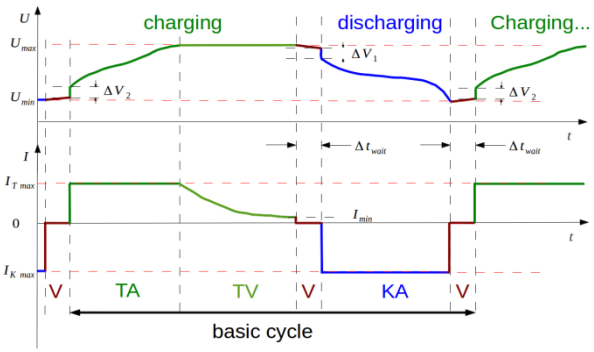

Figure 2. Basic charging-discharging cycle

2. Simple discraging process at constant current (KA): It is a constant current discharging process. It used to model the simplest usage of the cell: for a given task there must be enough current available. This process is to be changed for a more complicated when we want to model some more complex tasks of accumulator cells.

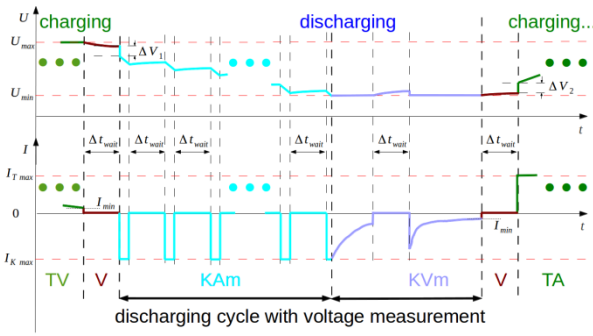

Figure 3. Discharging procedure with measuring the open circuit voltage at rest state

3. Simple discharging process at constant voltage (KV): This process is reserved for as complete discharging of the cell as possible before we use the charging process with measuring the open cycle voltage of the cell at rest (KM).

4. Charging process with measuring the open cycle voltage of the cell at rest (KM) (see Fig. 4.): it consists of two subprocesses, namely a constant current (KAM) and a constant voltage (KVM) processes. The latter one is incorporated to achieve as full as allowable charged state of the accumulator cell. During this discharging process after some portion of the charge-capacity of the cell being charged the test system wait some time (Δt_{wait}) to allow the cell to get into its rest state. At the end of this dwell-time we get the open cycle voltage of the cell at rest. It is important for comparison of the behaviour of the cell with the data from the literature.

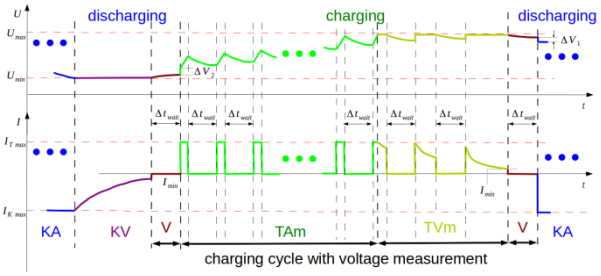

Figure 4. Charging procedure with measuring the open circuit voltage (OCV) at rest state

5. Discharging process with measuring the open cycle voltage of the cell at rest (TM) (see Fig. 4.): it consists of two subprocesses, namely a constant current (TAM) and a constant voltage (TVM) processes. The discharging process is interrupted from time to time when some given portion of the cpapcity charge is discharged.

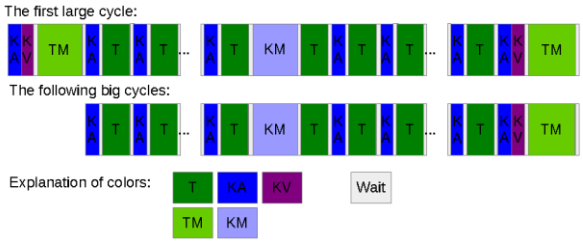

Figure 5. Testing cycles

The subprocesses described above are organized into large cycles shown in Fig. 5. These large cycles are saving data into separate datafiles. In each large cycles there are 20 simple charging processes (T). It can be noticed that the discharging process at constant voltage (KV) is applied only before the mesuring charging process (TM).

3. Testing procedure

During the test we save to a file some data [see Fig. 2.] collected by the sbRIO device. A log-file is written: in each raw the time of measurement, the code of the current procedure, the ambient temperature, the voltage of the cell, the prescribed current, the measured current, and at the end the calculated charged charge and the discharged charge is saved (depending on whether charging or discharging process is running).

Figure 6. Data saved to a log-file

We start with simple discharging processes (constant current process) to learn about the aging properties of the cells. Our system is suitable for testing the cells with complex discharging processes also: the discharging current can be programmed freely.

4. Preliminary results

We made some preliminary measurements on a Samsung SDI lithium-ion rechargable cell (Model : ICR18650-26F). The most important data from its datasheet is given in Table 1.

Table 1. The nominal specifications of the tested Li-ion accumulator cell

Item	Value
Nominal capacity	2600 mAh
Charging voltage	4.2 V
Max. charge current	2600 mA
Max. discharge current	5200 mA
Discharge cut-off voltage	2.75 V
Operating temp. (charge)	0-45 ^{o}C
Operating temp (discharge)	-20-60 ^{o}C

We made a preliminary test measurement on a new accumulator cell to find out what sort of properties of the time-dependence of the current and the voltage of the cell can be identified as parameters that will help us to estimate the state of the cell.
Our short measurement consisted only of three simple charging (T), discharging (KA) processes, a charging process with measuring the open-circuit voltage (OCV) of the cell at rest (TM), and a discharging process with measuring the OCV of the cell at rest (KM). The time dependence of the current and the voltage of the cell can be seen on Fig. 6. and on Fig. 7.
As it can be seen from Fig. 7. that the prescribed charging current is 2600 mA, and the prescribed discharging current is -4500 mA. As it can be seen the prescribed charging current is so high that practically it cannot be maintained for any time within the voltage constrain limit.

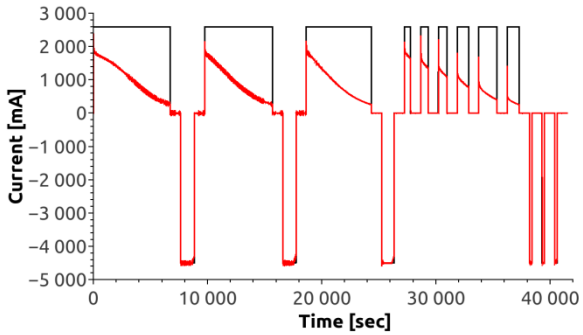

Figure 7. Prescried (black) and measured (red) current variation during three basic charging-discharging cycles and an OCV measuring charging cycle

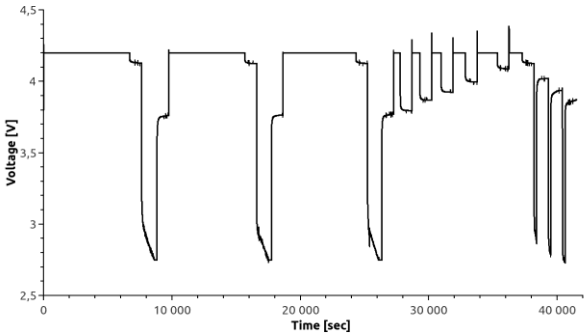

Figure 8. Measured cell-voltage variation during three basic charging-discharging cycles and an OCV measuring charging cycle

To have a chance to identify the state of the accumulator cell we have to find characteristics in the time dependent current and voltage curves that are not determined by the test system itself, characteristics that are determined by the cell. The characteristics found are listed in Table 2.

Table 2. Characteristics of the time-dependent current and voltage curves determined by the state of the accumulator cell

In process	Charecteristics
Charging	1: voltage drop 2: duration of charging at constant current 3: current decay rate 4: duration of charging at constant voltage 5: charged charge
Dwell-time after charging	1: voltage drop 2: voltage setting rate 3: open circuit voltage
Discharging	1: voltage drop 2: duration of discharge process 3: voltage reduction rate 4: current reduction rate 5: discharged charge
Dwell-time after discharging	1: voltage drop 2: voltage setting rate 3: open circuit voltage

It can be noticed in Fig. 8. that there is a voltage drop at every change of the mode of operation. This drop of voltage is determined by the accumulator cell.

Charging process

After a dwell preiod turning on the charging current cause a drop of the voltage of cell. The duration of the charging process is determined by the state (dominantly the state of helth) of the accumulator cell.

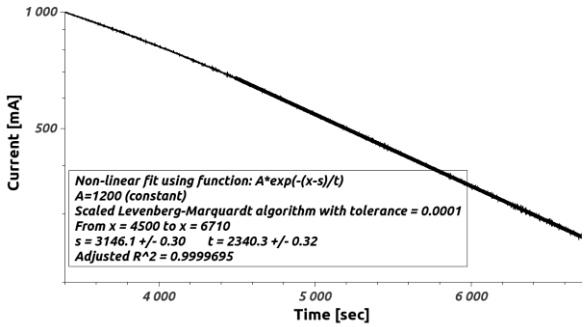

Figure 9. Current exponential decay rate during constant voltage charging (TV)

When the testing system changed to constant voltage charging mode the charging current decrease exponentially (see Fig. 9.).

Dwell-time after charging

Just after turning off the charging process there appear a voltage drop (see Fig. 8.).

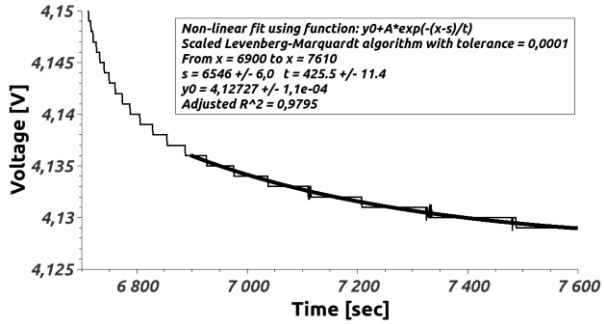

Figure 10. Voltage exponential setting rate and the open circuit voltage value at the end of the dwell-time after charging

As the cell is in open circuit state, its state changes slowly: its open circuit voltage value approximate exponentially its value at rest (see Fig. 10.).

Discharging

There appears a voltage drop when the discharging current is turned on.
Approaching the end of the discharging process with constant current the voltage of the cell decreases linearly to the limiting voltage (2.75 V see Table 1.) value (see Fig. 11.).

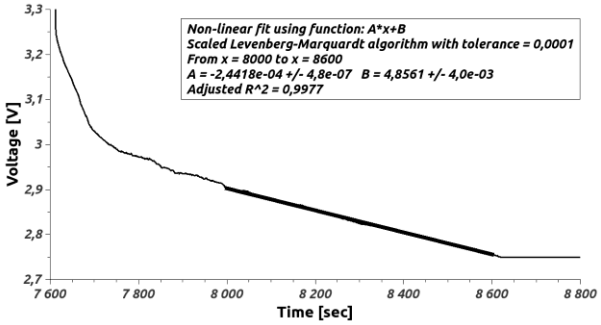

Figure 11. Voltage reduction rate at the end of the constant current discharging process (KA)

Just before the discharging process is turned off the absolute value of the current can decreas a bit (5%). In Fig. 12. one can see that this decrease can be approximated as linear.

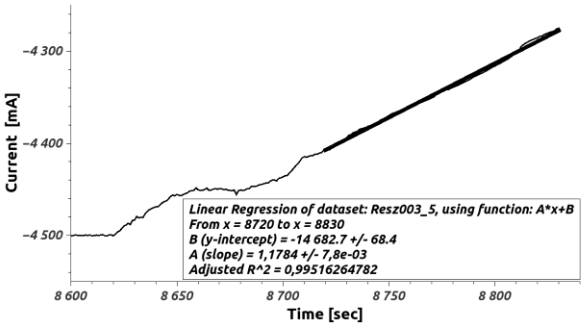

Figure 12. Currend reduction rate after the constant current discharging process (KA) just before turning off the discharging current

Dwell-time after discharging

After turning off the discharging current there appears a voltage drop of the cell (see Fig. 8.).
In this period of time the state of the cell changes slowly: its open circuit voltage approximate exponentially it value at rest (see Fig. 13.).

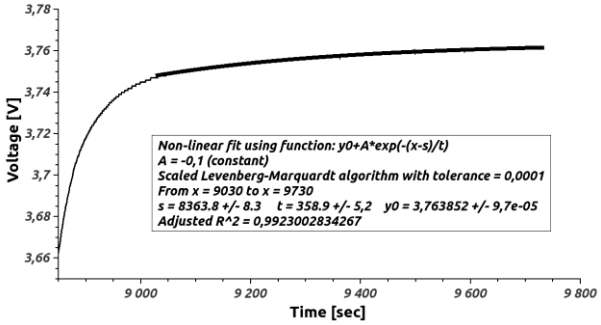

Figure 13. Voltage exponential setting rate and the open circuit voltage value at the end of the dwell-time after discharging

5. Summary

Our main result is that we have identified those characteristics (see Table 2.) of the time-dependence of the current and voltage of the cell that can be utilized for estimation of the state of an accumulator cell.

A plenty of mesurement has to be done to find the functional dependence between the state of an acculator cell and the characteristics listed in Table 2.

Acknowledgement
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THE PARAMETER ESTIMATION OF THE LINK PERFORMANCE FUNCTIONS

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Abstract
The link performance function is a mathematical representation of the relation between flow (i.e. traffic volume) and travel cost (i.e. travel time) for any given link in the network. The results are presented of the calibration of performance functions. Two types of functions are presented: (a) linear function and (b) nonlinear functions, based on the widely used Bureau of Public Roads form. These functions are intended for use in network equilibrium studies requiring the assignment of explicit car flows.

Keywords:
link performance function, travel simulation, regression

1. Introduction

Today it is an important challenge to minimize the travel cost of a particular urban transport system. The travel cost is usually considered to be travel time between the origin and the destination of travel. In order to calculate travel time between origin and destination, the network representation of the transport area is used [2].

The network includes two types of elements: a set of nodes (intersection of roads) and a set of links (street) connecting these nodes.

The other part of the urban transport system is the traffic flow (the mass of the moving vehicles).

The function, which is called Link Performance Function (LPF) [1], is presenting the relationship between link delays and link flows.

A performance function for a typical approach to a signalized intersection is shown in Figure 1. This function captures both the time spent in traveling along the approach under consideration and the delay at the downstream intersection. The travel time at zero flow is known as the free-flow travel time. At this point, a traveling car would not be delayed because of interaction with any other car moving along the link. The only source of delay at this point is the time associated with traversing the link and the expected delay associated with the probability of being stopped by a red signal indication. As the flow increases, the travel time monotonically increases since both the travel time along the approach increases (because of vehicle interactions at higher traffic densities) and the intersection delay increases (because of queueing phenomena) with the flow.

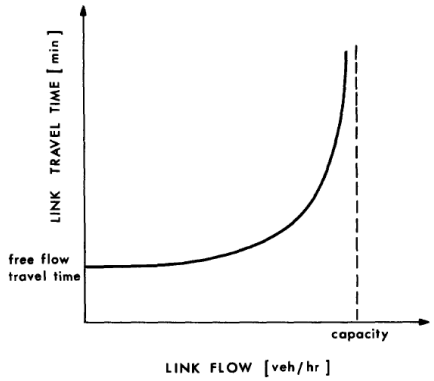

Figure 1. Typical link performance function for an approach to a signalized intersection.

Characteristically, the performance function is asymptotic to a certain level of flow known as the capacity of the transportation facility under consideration. The capacity is the maximum flow that can go through any transportation facility. When the flow approaches capacity, the queues at the intersection will start growing, clogging upstream intersections and finally causing traffic to come to a halt.

2. Common Link Performance Functions

The original intersection delay formula used by traffic engineers was calibrated by Webster [3] on the basis of Monte Carlo simulations:

$$t = \frac{r^2}{2c(1-\rho)} + \frac{R^2}{2q(1-R)} - 0.65\left(\frac{c}{q^2}\right)^{1/3} R^{(2+5g/c)}.$$

This is a complicated functional form, thus it imposes a significant computational burden on the calculations. During the equilibrium calculations the link performance functions have to be evaluated numerous times, so we use simplified formula.

A simplified function that is often used in practice is the equation developed by the U.S. Bureau of Public Roads (BPR). This equation is given by

$$t = t^0 \left[1 + \alpha \left(\frac{q}{C}\right)^{\beta}\right]. \quad (1)$$

In this formula t and q are the travel time of the flow, t^0 is the free-flow travel time, and C is the capacity of link. The quantities α and β are model parameters, for which the value $\alpha = 0.15$ and $\beta = 4.0$ are typically used to the highway.
In contrast with traffic flow theory the BPR curves are not asymptotic to any capacity value. A function that is asymptotic to a capacity flow was proposed by Davidson, based on queueing theory considerations. This function is

$$t = t^0 \left[1 + J\left(\frac{q}{C - q}\right)\right], \quad (2)$$

where *C* is the road's capacity and *J* is a parameter of the model. As with the BPR function, t^0 denotes the free-flow travel time (i.e., the travel time at zero flow).

3. The method of the estimation

First we will attempt to model the relationship between the flow and the travel time by fitting a linear equation (3) to observed data set.

$$t = a + bq. \quad (3)$$

The coefficients of the linear regression line (3) are estimated by the least square method

$$\hat{b} = \frac{\sum_{i=1}^{n}(q_i - \bar{q})(t_i - \bar{t})}{\sum_{i=1}^{n}(t_i - \bar{t})^2},$$

$$\hat{a} = \bar{t} - \hat{b}\bar{q},$$

where $\bar{q}$ and $\bar{t}$ are the sample means of the flow (q) and the travel time (t).
In the model of BPR the parameters can be estimated by using a linear regression if a logarithmic transformation is used on the data set. First we order the equation (1)

$$\frac{t - t^0}{t^0} = \alpha \left(\frac{q}{C}\right)^{\beta},$$

next we use logarithmic transformation

$$ln\left(\frac{t - t^0}{t^0}\right) = ln(\alpha) + \beta ln\left(\frac{q}{C}\right).$$

Now if we introduce the following variable

$$v = ln\left(\frac{t - t^0}{t^0}\right),$$

$$u = ln\left(\frac{q}{C}\right),$$

then the coefficients of the linear regression line

$$v = \ln(\alpha) + \beta u$$

can be estimated by the least square method again.
Similarly we can transform the Davidson's model to linear regression model without the intercept term. We introduce the following variable

$$w = \frac{t - t^0}{t^0},$$

$$z = \frac{q}{C - q}.$$

Then the coefficients of the linear regression line

$$w = Jz \quad (4)$$

can be estimated by the ordinary least squares

$$\hat{J} = \frac{\sum_{i=1}^{n} q_i t_i}{\sum_{i=1}^{n} {t_i}^2}.$$

4. Microscopic simulation of the traffic

The traffic model used here is based on a microscopic simulation of movements of individual vehicles through a network. The essential property of our model is that the vehicles move in real time and that their space-time trajectories are determined by IDM car-following model, network controls such as stop on red and speed limit. The parameter values of the IDM were calibrated in [4].

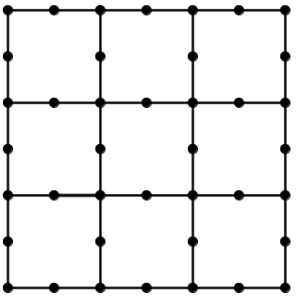

Figure 2. The Manhattan network.

In our Manhattan test bench start 12000 vehicles. We observe a 500 m long route with a signalized intersection on the end in the inside of the network. The cycle time of the traffic lights was 100 sec long, and the green time was 25 sec long. The departure of the intersection is 2.5 seconds per vehicle, so the capacity of the route was 360 vehicles per hour. The free-flow travel time can be computed by the following: the travel time is the sum of the average running time at zero flow level and the average time spent queueing at intersections, at that flow level. The average velocity of a car was 55 km/h, so it takes 32.73 seconds to drive the 500 m long route. If the arrival time at the intersection is a random time under the uniform distribution, then the average time spent queueing is

$$\frac{1}{4}\cdot 0 + \int_0^{75} \frac{1}{100} t dt = 28.125$$

seconds. That is the computed free-flow travel time is 60.855 seconds.
We measured the flow on the link in vehicle per hour and the average travel time in seconds. The result of the simulations is shown in Figure 3.

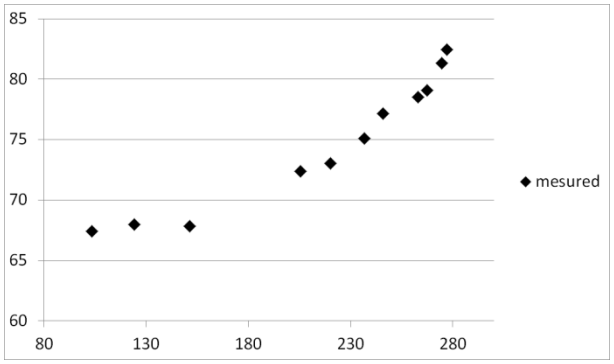

Figure 3. The measured data.

5. The estimation of link delay functions parameters

The estimated coefficients of the linear regression line are
$\hat{a} = 56.7126,\ \hat{b} = 0.0838,$
of BPR link performance function are
$\hat{\alpha} = 0.4215,\ \hat{\beta} = 1.2368,$
and Davidson's function is
$\hat{J} = 0.1124.$
We fitted these link performance functions to our data set, as we see in Figure 4.

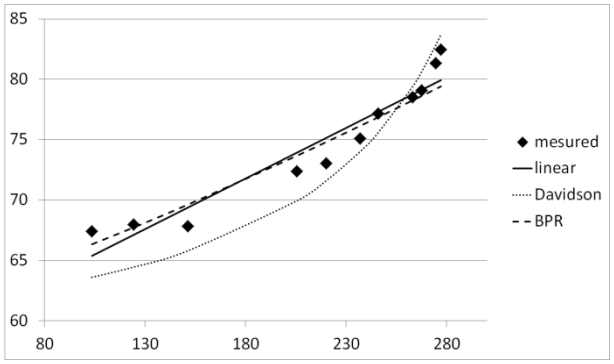

Figure 4. The fitted curves.

We computed all the three case the sample correlation coefficient (R) and the mean squared error (MSE) of the model. It was computed the correlation coefficient of the transformed sample in the BPR and Davidson's link performance functions.

Table 1. The value of R and MSE

	linear	BPR	Davidson
R	0.9565	0.9593	0.9944
MSE	2.3019	2.2266	4.5257

The correlation coefficient is very high in all three cases, moreover it is the best in the case Davidson's function, however the mean squared error is the greatest in this case. The correlation coefficient gives the quality of a least squares fitting to the data set, but the best line is not fitting on the pole (Figure 5), however in model (4) we required it.

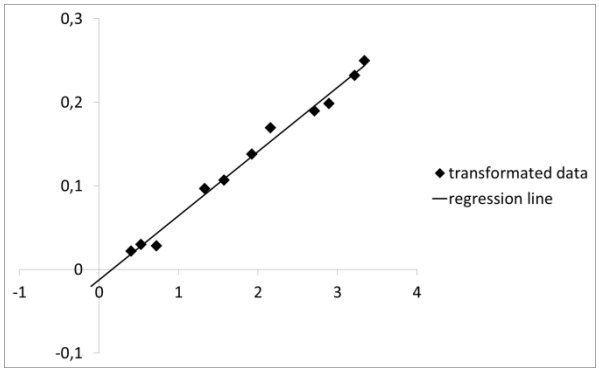

Figure 5. The best line to the transformed data.

We estimated the value of $\boldsymbol{t^0}$ by the least square method in model (2). That is we introduced the variable

$$z = \frac{q}{C-q}$$

and estimated the coefficients of the linear regression line

$$\boldsymbol{t = t^0 + (t^0 J)z}.$$

The value of the estimated free-flow travel time and parameter *J* are
$\hat{t^0} = 65.184,\ \hat{J} = 0.0777.$

The mean squared error of the new model is 0.2994. We can touch up the model of BPR by change the value of the free-flow travel time, but it requires other method to find the best.
Summarizing up we can use linear model in low flow and the Davidson's model close to the capacity.

Acknowledgement
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THE SIGNIFICANCE OF THE CONVEX COMBINATION CENTER

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Abstract
Certain inequalities are obtained for functions that are similar to convex functions. Acting with such functions to convex combinations with the common center, we achieve the results which are inherent to convex functions. Functions of one and two variables are used in these considerations. The point of the work is that the results can be further generalized to higher dimensions by using simplex and function of several variables.

Keywords:
convex combination, common center, triangle, simplex

1. Introduction

Let X be a real linear space, and let $\mathrm{C} \subseteq \mathrm{X}$ be a convex set. A function $f : \mathrm{C} \to \mathrm{R}$ is convex if the inequality

$$f\left(\sum_{i=1}^{n} \alpha_i x_i\right) \le \sum_{i=1}^{n} \alpha_i f(x_i) \qquad (1)$$

holds for all convex combinations of points $x_i \in \mathrm{C}$. Let $\mathrm{A} \subseteq \mathrm{X}$ be an affine set. A function $f : \mathrm{A} \to \mathrm{R}$ is affine if the equality holds in equation (1) for all affine combinations of points $x_i \in \mathrm{A}$. If we have two affine combinations with the common center,

$$\sum_{i=1}^{n} \alpha_i x_i = \sum_{j=1}^{m} \beta_j y_j, \qquad (2)$$

then every affine function f satisfies the equality

$$\sum_{i=1}^{n} \alpha_i f(x_i) = \sum_{j=1}^{m} \beta_j f(y_j). \qquad (3)$$

To define a convex function we usually take $n = 2$ in equation (1). Applying the mathematical induction Jensen has attained the famous inequality in equation (1), see [1]. Numerous books and papers were written on Jensen's inequality. For example, see book [2] and paper [3].

2. Functions of One Variable

The main result of this section is Theorem 2.1 relying on the idea of a convex function graph and its chord line. Using a function that is more general than convex function, and two convex combinations with the common center, we obtained the Jensen type inequality.

Let $[a,b] \subset \mathrm{R}$ be a bounded closed interval with endpoints $a < b$. Then every number $x \in \mathrm{R}$ can be uniquely presented as the binomial affine combination

$$x = \frac{b-x}{b-a} a + \frac{x-a}{b-a} b, \qquad (4)$$

which is convex if, and only if, the number x belongs to the interval $[a,b]$. Let $\mathrm{I} \subseteq \mathrm{R}$ be an interval containing $[a,b]$, let $f : \mathrm{I} \to \mathrm{R}$ be a function, and let $f^{\mathrm{line}}_{\{a,b\}} : \mathrm{R} \to \mathrm{R}$ be the function of the line passing through the points $A(a, f(a))$ and $B(b, f(b))$ of the graph of f. Applying the affinity of the function $f^{\mathrm{line}}_{\{a,b\}}$ to the combination in (4), we obtain its equation

$$f^{\mathrm{line}}_{\{a,b\}}(x) = \frac{b-x}{b-a} f(a) + \frac{x-a}{b-a} f(b). \qquad (5)$$

The consequence of the representations in equations (4) and (5) is the fact that every convex function $f : \mathrm{I} \to \mathrm{R}$ satisfies the inequality

$$f(x) \le f^{\mathrm{line}}_{\{a,b\}}(x) \text{ for } x \in [a,b], \qquad (6)$$

and the reverse inequality

$$f(x) \ge f^{\mathrm{line}}_{\{a,b\}}(x) \text{ for } x \in \mathrm{I} \setminus (a,b). \qquad (7)$$

In the following theorem, we use the functions satisfying the inequalities in equations (6) and (7).

Theorem 2.1. 15 *Let $\mathrm{I} \subseteq \mathrm{R}$ be an interval, let $[a,b] \subseteq \mathrm{I}$ be a closed interval with endpoints $a < b$, and let $f : \mathrm{I} \to \mathrm{R}$ be a function satisfying equations (6)-(7). Let $\sum_{i=1}^{n} \alpha_i a_i$ be a convex combination of points $a_i \in [a,b]$, and let $\sum_{j=1}^{m} \beta_j b_j$ be a convex combination of points $b_j \in \mathrm{I} \setminus (a,b)$.*

If the above convex combinations have the common center

$$\sum_{i=1}^{n}\alpha_i a_i = \sum_{j=1}^{m}\beta_j b_j, \tag{8}$$

then we have the inequality

$$\sum_{i=1}^{n}\alpha_i f(a_i) \le \sum_{j=1}^{m}\beta_j f(b_j). \tag{9}$$

Proof. Using the properties of the function f, and applying the affinity of the function $f^{\text{line}}_{\{a,b\}}$, we get

$$\begin{aligned}\sum_{i=1}^{n}\alpha_i f(a_i) &\le \sum_{i=1}^{n}\alpha_i f^{\text{line}}_{\{a,b\}}(a_i)\\ &= f^{\text{line}}_{\{a,b\}}\left(\sum_{j=1}^{m}\beta_j b_j\right)\\ &\le \sum_{j=1}^{m}\beta_j f(b_j)\end{aligned} \tag{10}$$

finishing the derivation of equation (9). □

The function used in Theorem 2.1 is presented in Figure 1.

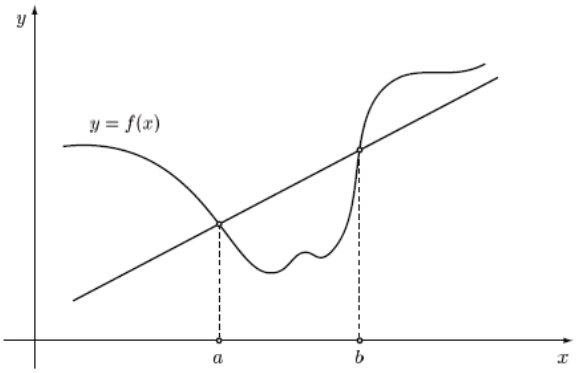

Figure 1. A function satisfying equations (6)-(7)

Involving the binomial convex combination $\alpha a + \beta b$ to the equality in equation (8) by assuming that

$$\sum_{i=1}^{n}\alpha_i a_i = \alpha a + \beta b = \sum_{j=1}^{m}\beta_j b_j, \tag{11}$$

and following the proof of Theorem 2.1, we achieve the double inequality

$$\sum_{i=1}^{n}\alpha_i f(a_i) \le \alpha f(a) + \beta f(b) \le \sum_{j=1}^{m}\beta_j f(b_j). \tag{12}$$

Corollary 2.2. 16 *Let $f:\mathrm{I}\to\mathrm{R}$ be a function satisfying equations (6)-(7), and let $c = \sum_{j=1}^{m}\beta_j b_j$ be a convex combination of points $b_j \in \mathrm{I}\setminus(a,b)$. If the center c belongs to $[a,b]$, then*

$$f\left(\sum_{j=1}^{m}\beta_j b_j\right) \le \sum_{j=1}^{m}\beta_j f(b_j). \tag{12}$$

Corollary 2.3. 17 *A convex function $f:\mathrm{I}\to\mathrm{R}$ satisfies Theorem 2.1 for every closed interval $[a,b]\subseteq\mathrm{I}$ with endpoints $a<b$.*

Corollary 2.4. 18 *Let $f:\mathrm{I}\to\mathrm{R}$ be a function such that it satisfies Theorem 2.1 for every closed interval $[a,b]\subseteq\mathrm{I}$ with endpoints $a<b$. Then f is convex.*

Proof. Let

$$c = \beta_1 b_1 + \beta_2 b_2 \tag{13}$$

be a binomial convex combination of points $b_1, b_2 \in \mathrm{I}$ such that $b_1 < b_2$. Taking $a = b_1$ and $b = b_2$, equation (11) becomes the common center of the trivial convex combination $c \in [a,b]$ and the binomial convex combination $\beta_1 b_1 + \beta_2 b_2$ of points $b_1, b_2 \in \mathrm{I}\setminus(a,b)$. We can apply the corollary assumption, and get the inequality

$$f(\beta_1 b_1 + \beta_2 b_2) = f(c) \le \beta_1 f(b_1) + \beta_2 f(b_2) \tag{14}$$

which proves the convexity of the function f.

3. Functions of Several Variables

The main result in this section is Theorem 3.4 generalizing Theorem 2.1 to higher dimensions. Example 3.3 shows that we can not transfer all results of Section 2 to higher dimensions.

Let $\mathrm{C}\subseteq\mathrm{R}^2$ be a convex set, and let $\Delta = \mathrm{conv}\{A,B,C\}\subseteq\mathrm{C}$ be a triangle with vertices A, B and C. In what follows we use a function $f:\mathrm{C}\to\mathrm{R}$ that satisfies the inequality

$$f(P) \le f^{\text{plane}}_{\{A,B,C\}}(P) \text{ for } P\in\Delta, \tag{15}$$

and the reverse inequality

$$f(P) \ge f^{\text{plane}}_{\{A,B,C\}}(P) \text{ for } P\in\mathrm{C}\setminus\Delta^o, \tag{16}$$

where $f^{\text{plane}}_{\{A,B,C\}}$ is the function of the plane passing through the corresponding points of the graph of f, and Δ^o is the interior of Δ.

The generalization of Theorem 2.1 to functions of two variables is as follows.

Lemma 3.1. 19 *Let $\mathrm{C}\subseteq\mathrm{R}^2$ be a convex set, let $\Delta\subseteq\mathrm{C}$ be a triangle with vertices A, B, C, and let $f:\mathrm{C}\to\mathrm{R}$ be a function satisfying equations (15)-(16). Let $\sum_{i=1}^{n}\alpha_i A_i$ be a convex combination*

of points $A_i \in \Delta$, *and let* $\sum_{j=1}^{m} \beta_j B_j$ *be a convex combination of points* $B_j \in \mathrm{C} \setminus \Delta^o$.

If the above convex combinations have the common center

$$\sum_{i=1}^{n} \alpha_i A_i = \sum_{j=1}^{m} \beta_j B_j, \tag{17}$$

then we have the inequality

$$\sum_{i=1}^{n} \alpha_i f(A_i) \le \sum_{j=1}^{m} \beta_j f(B_j). \tag{18}$$

Proof. We can implement the same analytic procedure as in Theorem 2.1 using the affinity of the plane function $f^{\text{plane}}_{\{A,B,C\}}$. □

Including the trinomial convex combination $\alpha A + \beta B + \gamma C$ to the equality in equation (17) by assuming that

$$\sum_{i=1}^{n} \alpha_i A_i = \alpha A + \beta B + \gamma C = \sum_{j=1}^{m} \beta_j B_j, \tag{19}$$

and applying Lemma 3.1 to the left and right equality of the above equation, we obtain the double inequality

$$\begin{aligned} \sum_{i=1}^{n} \alpha_i f(A_i) &\le \alpha f(A) + \beta f(B) + \gamma f(C) \\ &\le \sum_{j=1}^{m} \beta_j f(B_j). \end{aligned} \tag{20}$$

Corollary 3.2. 20 *Let* $f : \mathrm{C} \to \mathrm{R}$ *be a function satisfying equations (15)-(16), and let* $D = \sum_{j=1}^{m} \beta_j B_j$ *be a convex combination of points* $B_j \in \mathrm{C} \setminus \Delta^o$.

If the center D *belongs to* Δ, *then*

$$f\left(\sum_{j=1}^{m} \alpha_i B_j \right) \le \sum_{j=1}^{m} \beta_j f(B_j). \tag{21}$$

The next example demonstrates that a generalization of Corollary 2.3 to convex functions of two variables is not possible.

Example 3.3. 21 *Take the convex function* $f(x,y) = x^2 + y^2$, *the triangle with vertices* $A(0,0)$, $B(3,0)$ *and* $C(0,3)$, *and the outside points* $B_1(1,-1)$, $B_2(2,2)$ *and* $B_3(-1,1)$.

Then we have

$$\frac{1}{3}A + \frac{1}{3}B + \frac{1}{3}C = \frac{1}{4}B_1 + \frac{1}{2}B_2 + \frac{1}{4}B_3 \tag{22}$$

and

$$\begin{aligned} 6 &= \frac{1}{3} f(A) + \frac{1}{3} f(B) + \frac{1}{3} f(C) \\ &> \frac{1}{4} f(B_1) + \frac{1}{2} f(B_2) + \frac{1}{4} f(B_3) = 5. \end{aligned} \tag{23}$$

Lemma 3.1 which refers to the triangles can be extended to simplexes. In short, the convex hull of points $C_1, \ldots, C_{p+1} \in \mathrm{R}^p$ is a p-simplex in R^p if the points $C_1 - C_{p+1}, \ldots, C_p - C_{p+1}$ are linearly independent.

Let $\mathrm{C} \subseteq \mathrm{R}^p$ be a convex set, and let $\mathrm{S} = \mathrm{conv}\{C_1, \ldots, C_{p+1}\} \subseteq \mathrm{C}$ be a p-simplex with vertices $C_1, \ldots, C_{p+1}$. In this observation we use a function $f : \mathrm{C} \to \mathrm{R}$ that satisfies the inequality

$$f(P) \le f^{\text{hyperplane}}_{\{C_1,\ldots,C_{p+1}\}}(P) \quad \text{for } P \in \mathrm{S}, \tag{24}$$

and the reverse inequality

$$f(P) \ge f^{\text{hyperplane}}_{\{C_1,\ldots,C_{p+1}\}}(P) \quad \text{for } P \in \mathrm{C} \setminus \mathrm{S}^o, \tag{25}$$

where $f^{\text{hyperplane}}_{\{C_1,\ldots,C_{p+1}\}}$ is the function of the hyperplane passing through the corresponding points of the graph of f.

Theorem 3.4. 22 *Let* $\mathrm{C} \subseteq \mathrm{R}^p$ *be a convex set, let* $\mathrm{S} = \mathrm{conv}\{C_1, \ldots, C_{p+1}\} \subseteq \mathrm{C}$ *be a* p*-simplex with vertices* $C_1, \ldots, C_{p+1}$, *and let* $f : \mathrm{C} \to \mathrm{R}$ *be a function satisfying equations (24)-(25). Let* $\sum_{i=1}^{n} \alpha_i A_i$ *be a convex combination of points* $A_i \in \mathrm{S}$, *and let* $\sum_{j=1}^{m} \beta_j B_j$ *be a convex combination of points* $B_j \in \mathrm{C} \setminus \mathrm{S}^o$.

If the above convex combinations have the common center

$$\sum_{i=1}^{n} \alpha_i A_i = \sum_{j=1}^{m} \beta_j B_j, \tag{26}$$

then we have the inequality

$$\sum_{i=1}^{n} \alpha_i f(A_i) \le \sum_{j=1}^{m} \beta_j f(B_j). \tag{27}$$

Proof. To derive the inequality in equation (27), we use the affinity of the hyperplane function.

Including the $(p+1)$-membered convex combination $\sum_{k=1}^{p+1} \gamma_k C_k$ to the equality in equation (26) in a way that

$$\sum_{i=1}^{n}\alpha_i A_i = \sum_{k=1}^{p+1}\gamma_k C_k = \sum_{j=1}^{m}\beta_j B_j, \qquad (28)$$

and respecting Theorem 3.4, we get the double inequality

$$\sum_{i=1}^{n}\alpha_i f(A_i) \le \sum_{k=1}^{p+1}\gamma_k f(C_k) \le \sum_{j=1}^{m}\beta_j f(B_j). \qquad (29)$$

Corollary 3.5. 23 *Let* $f:\mathrm{C}\to\mathrm{R}$ *be a function satisfying equations (24)-(25), and let* $D=\sum_{j=1}^{m}\beta_j B_j$ *be a convex combination of points* $B_j\in\mathrm{C}\setminus\mathrm{S}^o$.

If the center D *belongs to the set* S*, then we have the inequality*

$$f\left(\sum_{j=1}^{m}\alpha_i B_j\right) \le \sum_{j=1}^{m}\beta_j f(B_j). \qquad (30)$$

4. Conclusion

The above results can be transferred to integrals. We use the integral method with convex combinations. Something similar was done in [4] by observing different variants of inequalities.

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OPTIMIZATION QUESTIONS IN BITTORRENT COMMUNITIES

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Abstract
A BitTorrent community is a peer-to-peer (P2P) computer network. All users have restricted upload and download bandwidths, and they have different seed libraries, while various objectives could emerge in the network. The behavior of the peers is determined by the BitTorrent protocol which was designed originally for file exchange. However, other applications are also possible as BitTorrent Assisted Streaming Systems or BitTorrent Sync, for example.
This paper summarizes the main concepts of studying BitTorrent communities. After a brief introduction to BitTorrent networks and their applications, we will talk about the possibility of modeling P2P networks by simulators. On the other hand, it is possible to determine the "ideal" behavior of computer networks by solving optimization problems of the underlying flow networks.

Keywords:
optimization, BitTorrent, bandwidth allocation problem

1. Introduction

The main idea of the BitTorrent protocol [7] is to increase efficiency of file-sharing on the web by distributing the load of the original uploader among all the downloaders. Furthermore, distributed networks are known for excellent robustness compared to traditional centralized hierarchies.
Since Bram Cohen released the first version in 2001, various file-sharing networks were based on this protocol, and BitTorrent became one of the most popular services of the Internet. In November 2004, BitTorrent was generating 35% of total internet traffic, and in 2013, it was responsible for the usage of 3.35% worldwide bandwidth, what is more than half of the total bandwidth dedicated to file sharing [19]. Computer scientists' interest for analyzing this networks have been emerged together with the popularity of BitTorrent.
In consideration the wide scope of the TEAM conference, the present paper attempts to give only a brief introduction into the main concepts of studying such P2P networks. This approach hopefully helps to find connections to other conference participants' present and future works.

2. The BitTorrent protocol

The BitTorrent Protocol Specification [7] was released in 2008, and there were only three minor clarifications in the text until now. The reason is that the specification is not very strict, it contains a lot of recommendations for implementation details, as adaptable package sizes, and so on. Therefore the specification acts only as a guideline for the programmers of various BitTorrent clients, however, it tends to include de-facto rules too.
Figure 1 summarizes the process of file distribution with BitTorrent.

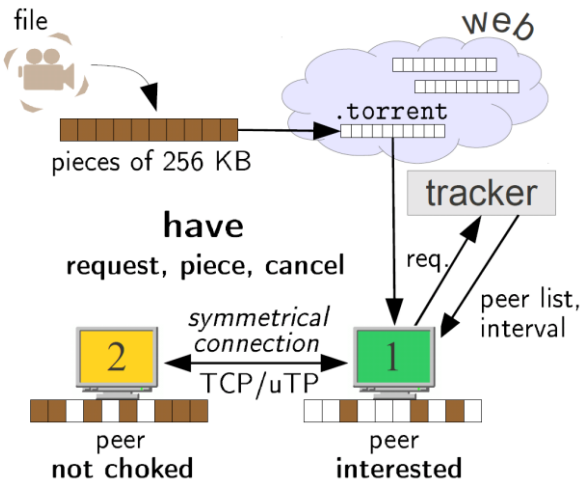

Figure 1. File distribution with BitTorrent

If someone would like to share a file, for example, his/her favorite home video, then he or she needs to create a metainfo file with `.torrent` extension. His/her BitTorrent client automatically splits the original file into small pieces, in most implementations the piece length is set to 256 KB.
As the metainfo file does not contain any sensitive information, the original uploader can make it available on the web. The `.torrent` file contains the URL of the tracker and some technical information about the pieces. The tracker is a central computer which coordinates the users, but it does not store any valuable content. For private file sharing, however, it is possible, that the original uploader is the tracker at the same time.
Suppose that User 1 wants to download the mentioned video, and it sends a request to the tracker. Its ID will be included in the peer list of the

swarm (the users who share the same content), and the response contains a compact representation of the peer list. Then User 1 establish symmetrical connections with other peers over TCP or uTP in order to exchange pieces of the file. They communicate with short messages. If one peer is interested in a given piece, and another is not choked, then data transfer takes place. When a peer get a non-corrupt piece it have to announce with a `have` message to all of his peers. This simple strategy lead to less than 0.1% bandwidth overhead [6].
Every peer asks for the pieces in random order, which increases the robustness of the system.
A small example for a swarm of three users can be seen in Figure 2.

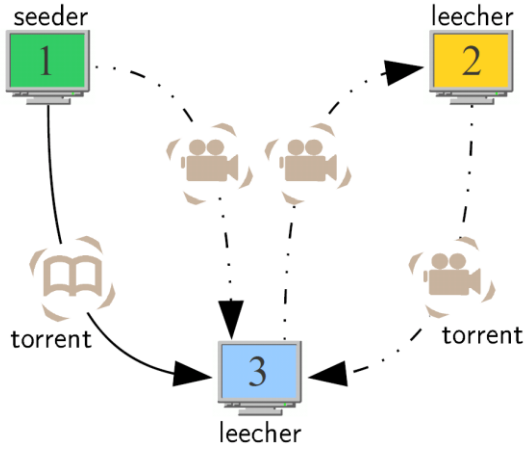

Figure 2. Swarm of three users

A peer who downloads and uploads in the same time is called a leecher. Seeder is the name of a peer, who completed the downloading and still uploads. Torrent refers to a shared file. The efficiency of BitTorrent shines up in big data distribution, however, there are no restrictions for the minimal size of the torrents.
It is polite to act as a seeder for a while [6]. Some communities require registration, and actuate accounting mechanisms in order to preserve free riding. This leads to lower resource contention than of the case of open BitTorrent sites [5].
Peers usually communicate with a small part of their swarms simultaneously. BitTorrent utilize a variant of tit-for-tat for choosing four peers to cooperate with in the same time, and they keep a free slot for optimistic unchoking (optimistic disconnection) [6, 7]. It means that the peers response on their four quickest connections, and they choose also one random peer for uploading to in the next ten seconds. Experiments of Lehman et al. shows, that optimistic disconnection is beneficial to swarm performance, as it helps to reach lower average download times. It increases the usage of total upload capacity, while results in more stable topologies, and therefore helps to reduce the negative effects of flash crowds [13].

To imagine the life circle of torrents, let us refer to the work of Izal et al. [12]. They studied a popular torrent, the 1.77 GB Linux Redhat 9 distribution in 2004, by analyzing the tracker logs for a five-month period. They found, that more than the quarter of all participants (51,000 of 180,000) connected to the swarm in the first five days (this phenomenon is called flash crowd). Average seeders remained connected for six and a half hours after finishing downloading. The seeders contributed about two times the uploading activity of the leechers. Their presence were the most dominant in the first five day (proportion of seeders and peers was over 40%), which can be explained by two factors: first, the seeders behaved altruistic; and second, the system prefers elder peers due to the tit-for-tat mechanism, therefore supports creating new seeds instead of threatening the security of downloading by dividing the resources evenly between users. Izal et al. diagnosed, that 81% of the download sessions were never finished, however, only 21.5% of the total data transfer belonged to these incomplete sessions.

3. Who is using BitTorrent?

Cuevas et al. introduce a socio-economic point of view [9] by discussing the motivation of the most intensive uploaders of the BitTorrent communities. They collected and analyzed data from Mininova and Pirate Bay, the most popular BitTorrent portals at the time of their measurements. They found, that the top 3% of the publishers, i.e. 100 users, contributed around 40% of the total published materials, while they were downloading almost nothing. Three groups of these top publishers can be distinguished: the altruistic, the profit-driven, and the malicious users. It seems that 45% of the top 100 publishers use a large number of usernames simultaneously to inject fake content to the system. They focus on video and software uploading. Cuevas et al. suggest that antipiracy agencies and malicious users can belong to this group. The former usually publishes fake versions of recent movies, while the latter is interested in sharing malware. Distressingly large amount of usernames (25%) and torrents (30%) seems to be fake. Fortunately, these contents are relatively unpopular, but still produce 25% of total downloads. Fake publishers seed for raised time and they run parallel seeds for up to 15 threads instead of the average 1. On the other hand, 48% of the non-fake top publishers seems to be also profit-driven, as they promote their web sites or private BitTorrent trackers in the uploaded contents. The remaining part of the top publishers is probably altruistic. They typically enclose very extensive descriptions of their torrents and ask for help of other users by seeding their contents.
On the other hand, the study of Cox et al. [8] focuses on the person behind the computer. They

analyzed the dataset of the Helsinki Institute for Information Technology, originated from an online survey during 2007 with 6103 answers, to find out the socio-economic background and attitudes of users of file sharing services toward legal and illegal file sharing. Cox et al. found that education and income have an inverted U shaped relationship with the probability of taking part in file sharing. Four groups can be distinguished: non-participants, leechers, seeders, and first-seeds (the first uploaders of a special content). The average age of the respondents were 33.34, 27.31, 25.20, and 23.97 years in the different groups, respectively. The social influence seems to be the main factor for involvement in file-sharing, as the participation of family members, friends, and colleges was usually related to bigger chances of participation of the respondents. Other main motivation was the prospect of financial savings. Finally, significant proportion of the first-seeders expected little chance for being caught participating in illegal file sharing, while saw itself as the group of masked philanthropists acting against incorrect legal regulations.

4. BitTorrent applications: storing and streaming

To the top of classic file-sharing, there are some further applications of BitTorrent growing in popularity.

BitTorrent Sync (BTSync, BitSync or BSync) is a new rival of the popular cloud file synchronization services, such as Dropbox, Microsoft OneDrive, and Google Drive. The BitTorrent Inc. released the private alpha in April 2013, and so far the only related academic publication is the paper of Farina et al. [10] which discusses the digital forensic possibilities in connection to BitSync. The main key and the main question of this application is privacy: can BitSync guarantee more security in comparison to the centralized cloud file synchronization services?

Media streaming is another interesting challenge for BitTorrent, and the two main field, as live streaming and video-on-demand, requires different approaches. Instead of the earlier concepts as IP level multicast and other tree-based systems at the application layer, BitTorrent offers a mesh-based architecture which is extremely robust against peer churn [14, 16]. High quality video-on-demand is more challenging than live streaming, as in the former case all the peers need different video chunks in the same time because of the asynchronous operation. Wu et al. [20] reveal that it is impossible to achieve maximum throughput of the BitTorrent network (optimal performance of the system) and maximal fairness (individual optimum) in the same time.

5. Optimal behavior, fairness conceptions

To determine optimal behavior of BitTorrent, it is essential to find an appropriate mathematical model of the system. Figure 3 contains a straightforward graph representation of the illustrative example of Figure 2.

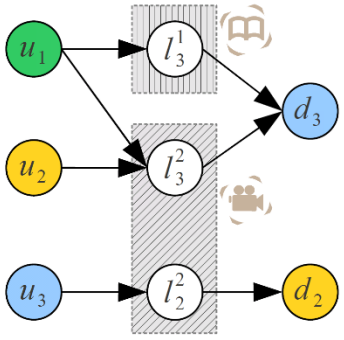

Figure 3. Bipartite graph representation of the earlier swarm

The colors refers to identical users with same color in Figure 2. The graph is bipartite, the upload and download activity of user i are represented by the nodes u_i and d_i accordingly and l_i^t represents the leeching session of user i in torrent t. With addition of a synthetic source and sink, we can get a traditional network model (Figure 4) of the given swarm.

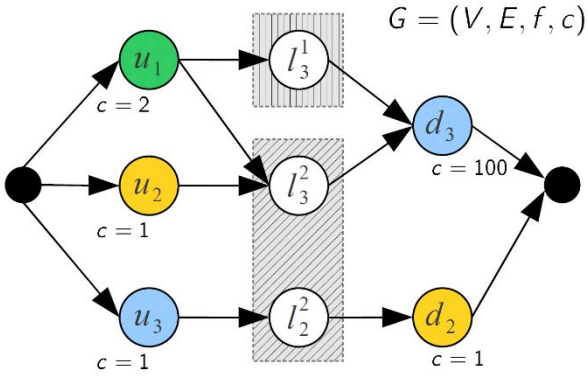

Figure 4. Network of the swarm

The edges of the graph represent the participation of the users in the leeching sessions as uploader or downloader. The flow function f assigns different amount of data exchange for the channels, while the capacity function c vindicates upload and download bandwidth constraints of the peers. This graph model was introduced by Capotă et al. [5] for examining the difference of achieved BitTorrent performance from the exact theoretical optimum.

Different objectives can be set for a P2P network as BitTorrent, as throughput maximization, max-min fairness, proportional fairness, and so on. Uchida and Kurose [18] generalized all the above mentioned popular objectives as weighted

α-proportional fairness. Consider the following optimization problem for bandwidth allocation:

$$\max \sum_{i=1}^{n} w_i \, \Phi_\alpha(x_i),$$

where $\boldsymbol{x} = \{x_1, \ldots, x_n\} \in \mathbb{C}$ is a feasible solution, and

$$\Phi_\alpha(x) = \begin{cases} \log x, & \text{if } \alpha = 1, \\ \dfrac{x^{1-\alpha}}{1-\alpha}, & \text{if } \alpha \geq 0, \alpha \neq 1. \end{cases}$$

This objective is identical to the maximum throughput for $\alpha = 0$, to the proportional fairness for $\alpha = 1$, to the potential delay minimization for $\alpha = 2$, and to the max-min fairness for $\alpha \to \infty$.
Figure 5 shows the maximal throughput [5, 18] or maximal flow allocation for the earlier example.

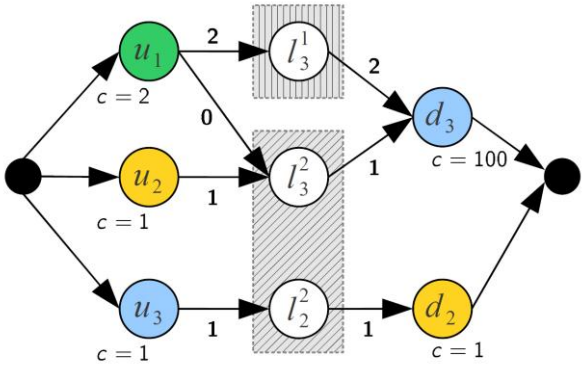

Figure 5. Maximum throughput

For comparison, the max-min fair allocation [5, 15] is presented in Figure 6.

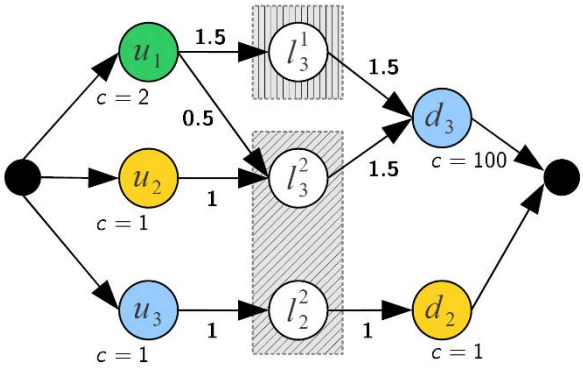

Figure 6. Max-min fair allocation

The max-min fair allocation, introduced by Bertsekas and Gallager [2], tends to equalize the download performance as far as possible, so it can be useful for media streaming, for example. In this special case, the max-min fair allocation guaranties maximal throughput also ($2 + 1 + 1 = 1.5 \cdot 2 + 1$ data unit), but it is not a necessity. Radunović and Le Boudec [17] recommended a unified watershed-like algorithm for the computation of max-min fair allocation. However, this leads to a mixed-integer nonlinear optimization problem [4] in every iteration for the above mentioned graph model of BitTorrent swarms. Asadpour and Saberi [1] discuss the approximation possibilities for the allocation problem of indivisible goods (where every flow needs to be a non-negative integer: $f(x) \in \mathbb{N} \; \forall x \in E$).

6. Performance analysis with simulation, measurement, and modeling

Different approaches are presented in the literature for studying BitTorrent networks. First of all, it is possible to emulate the behavior of a P2P system and study the impact of various mechanisms (e.g. optimistic disconnecting in [13]) due to experiments [3, 5]. These works can build upon available P2P simulators, for example PeerSym or GPS [21]. The simulations can be used for analyzing different scenarios and proposed modifications of the BitTorrent protocol due to the comparison of different performance indicators as total upload bandwidth of the system and Jain's fairness rate [20]. Measuring the same indicators in real BitTorrent networks [11] is more challenging, but it is the main key to get acquainted with the behavior of our working BitTorrent communities. On the other side, simulated or measured data could serve system analysts building realistic topological models of BitTorrent systems [22], comparing observed performance to the theoretic optimum [5], or getting inspiration for further theoretic findings.

7. Summary

This paper attempted to catch attention of wide range of TEAM participants (researchers, teachers, and college students) by surveying the main concepts and research questions connected to BitTorrent. The author's research concentrates on the rewriting possibilities of the mathematical models of the bandwidth allocation problem, and on heuristic approaches to determine good approximations for computing the max-min fair allocation of real BitTorrent systems.

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A SIMPLE FUZZY CONTROL DESIGN FOR SERIES HYBRID ELECTRIC VEHICLE

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Abstract
This paper proposes a simple fuzzy control design for a hybrid electric vehicle with a series connected powertrain system. In course of the research a complex system model was used which consists of three main components, i.e. the driver modeling subsystem, the control subsystem, and the subsystem modeling the hybrid vehicle. The primary objective was to develop a controller that ensures a low level dissipation in case of a predefined driving cycle by controlling the electric motor, the internal combustion engine, and the generator. In order to minimize fuel consumption and to take into consideration some other requirements a complex cost function was defined as objective function for the tuning process. A hill climbing type optimization approach was used for the tuning of the system.

Keywords:
fuzzy control, hybrid vehicle

1. Introduction

Hybrid electric vehicles (HEVs) have become commercially feasible products because they can combine some advantageous features of the conventional internal combustion engine vehicles (ICEVs), i.e. large driving range and rapid refueling, with the advantages of electric vehicles (EVs), i.e. low emission of harmful pollutants [4]. Although the development of EVs that ensure zero level emission is considered as the long term objective in medium term the development of HEVs is significantly motivated by the practical limits of the current battery and fuel cell technologies [16].

HEVs can be classified into four basic kinds: series [2] [3], parallel [7][12][16][22], series-parallel [9], and complex [4]. In our research, we adopted the series hybrid concept owing to its simplicity. Its details are described in Section 2.

Computational intelligence based solutions have been applied for a wide range of problems like control [14][15][17], expert systems [5][19], risk assessment [13], decision making systems [20], etc.. The objective of this paper is to present a simple fuzzy control solution for a series HEV. The controller has to ensure a low level dissipation in case of a predefined driving cycle by controlling the electric motor, the internal combustion engine, and the generator. The proposed solution was tried using simulations with a complex vehicle system model created in Simulink.

The rest of this paper is organized as follows. Section 2 presents shortly the structure of the whole model. Section 3 introduces the main steps of the control system design. The simulation and performance evaluation results are presented in Section 4 and the conclusions are drawn in Section 5.

2. System structure

Fig. 1 shows the functional block diagram of the series HEV. Its key feature is that the ICE is coupled with the generator (G), which produces electricity used either for charging the battery (B) or for providing power for the electric motor (EM). The later also can be used for power generation in case of braking. The vehicle has pure electric propulsion. The link between fuel tank (FT) and ICE is hydraulic; between ICE and generator as well as between electric motor and transmission system (T) is mechanical, while the links between generator, battery and electric motor are electrical. This engine assisted EV concept makes possible an extended driving range that is comparable to the driving range of ICEVs [4].

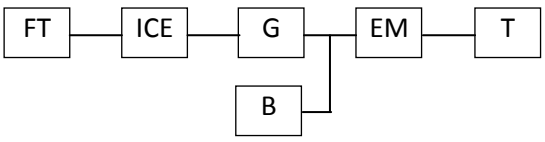

Figure 1. Block diagram of the whole system

The architecture of the whole system created in Simulink is given in Fig. 2. The first block produces the reference speed values prescribed by the applied driving cycle. The second block (Driver) models the driver and is responsible for tracking the driving cycle. The third block (Fuzzy_Control_HV_2) contains the fuzzy control presented in the following sections and the fourth block (Hybrid_system_continuous) contains the

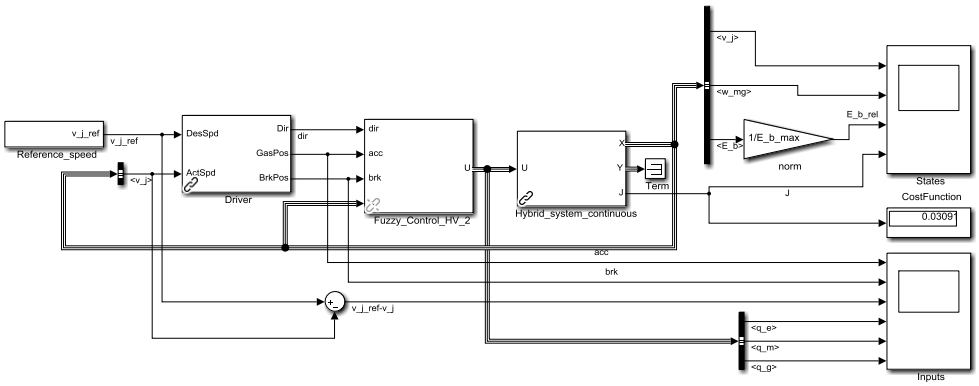

Figure 2. Block diagram of the whole system

series hybrid model. The first two blocks and the last block are described in [18]. The last three elements (right hand side) serve the visualization of the signals (see Fig. 8 and 9) and the cost function used for the evaluation of the control structure. Our study focuses on the third block; therefore the rest of this paper will be related only to this topic.

3. Fuzzy control system design

The Fuzzy-Control subsystem (block Fuzzy_Control_HV_2 in Fig. 2) implements the fuzzy logic using standard blocks from Matlab's Fuzzy Logic Toolbox, as well as some pre- and postprocessing operations that are necessary to ensure a normalized input to the fuzzy blocks and the transmission (further use of the normalized output of the fuzzy block).

3.1 Controller Inputs and Outputs

After the analysis of the vehicle model we chose the following characteristics as inputs of the control system:

- *dir* the movement direction of the car. Here the positive values indicate the forward movement, while the negative values indicate the reverse movement.
- *acc* a value belonging to the interval [0,1] indicating the position of the gas pedal.
- *brk* a value belonging to the interval [0,1] indicating the position of the brake pedal.
- *X* a vector with multiple components from which we use an indicator of the energy stored in the battery (E_b).

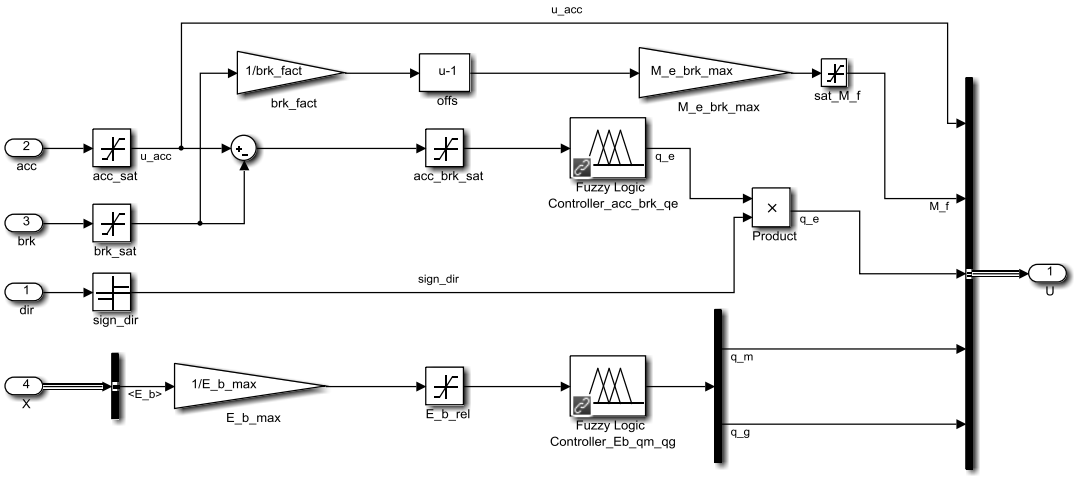

Figure 3. Block diagram of the control subsystem

Similarly the outputs of the controller are:

M_f the torque of the friction brake.

q_e a value belonging to the interval [0,1] indicating the control input of the electric motor.

q_m a value belonging to the interval [0,1] indicating the control input of the ICE.

q_g a value belonging to the interval [0,1] indicating the control input of the generator.

3.2 Definition of the structure of the control subsystem

The block diagram of the fuzzy subsystem is shown in Fig. 3. The control subsystem contains two fuzzy logic controller blocks, i.e. a SISO (single input single output) and a SIMO (single input multiple output) fuzzy system.

The first fuzzy block controls the electric motor by the means of the q_e signal based on the actual values of the gas and brake pedal positions (*acc_brk_sat*). The second fuzzy block controls the ICE (q_m) and the generator (q_g) based on the relative state of charge of the battery (E_{brel}). The *dir* parameter defines the sign of the q_e signal through a product block.

The acceleration signal was needed by the next subsystem (series hybrid model) too. Therefore its value is led out through the bus creator block. The torque of the friction brake (M_f) is calculated from the saturated value of the brake signal. The constant values used in course of the calculations are presented in Table 1.

Table 1. Constants

Constant	*Value*	*Unit*
M_{ebrk}^{max}	300	NM
brk_fact	0.5	-
E_b^{max}	4.3 10^6	J
B^{max}	0.0014	kg/s
e_{CO}^{max}	4.5747 10^{-4}	kg/s
e_{HC}^{max}	6.8620 10^{-4}	kg/s
e_{NOx}^{max}	5.7907 10^{-4}	kg/s
ξ_j^{max}	2.7500	m/s^2

3.3 Preprocessing Operations

In case of the first input (*dir*) we need only two discrete values that symbolize the forward (+1) and reverse (-1) movement of the vehicle. It is achieved with a sign block (see Fig. 3). In order to ensure an acceleration and a braking signal belonging to the [0,1] interval saturation blocks are applied. Furthermore, supposing that the driver does not press at the same time the gas and the brake pedals we could aggregate the two signals taking the brake signal with negative sign. The result is also saturated to the [-1,1] interval.

In case of the last input (E_b) that was taken from the bus signal *X* we created a relative (normalized) value for it by dividing the actual value by the maximum possible value given as a constant parameter of the vehicle system. In order to avoid the possibility of functioning errors of the fuzzy blocks we had to ensure that the resulting relative values always belong to the unit interval. This demand was fulfilled by the application of a saturation block.

3.4 Operational Characteristics of the Fuzzy System

In case of both fuzzy blocks we started with Ruspini type partitions and the parameters of the fuzzy sets were optimized for the cost function (1) using a simple hill climbing type algorithm. Further on only the characteristics of the resulting (optimized) fuzzy systems are going to be presented.

First Fuzzy System

In case of the first fuzzy system that controls the electric motor for both the antecedent and consequent universes of discourses we used trapezoid and triangle shaped membership functions (see Figs. 4~5). Partitions with six fuzzy sets were created in order to ensure a proper distinction between the braking and acceleration.

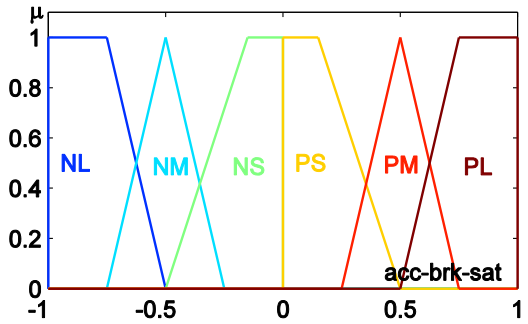

Figure 4. Antecedent partition of the first fuzzy block

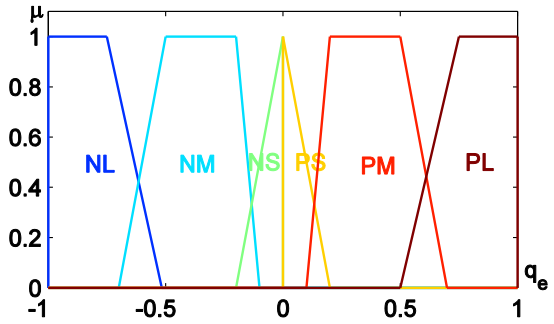

Figure 5. Consequent partition of the first fuzzy block

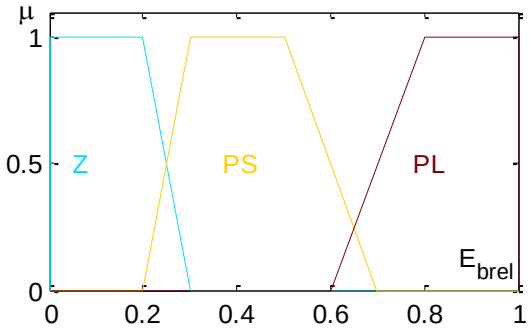

Figure 6. Antecedent partition of the second fuzzy block

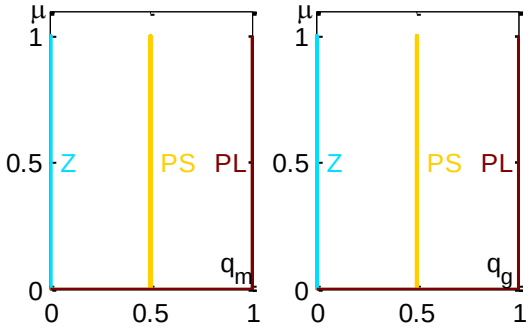

Figure 7. Consequent partitions of the second fuzzy block

We used the conventional simple notation mode (linguistic values) for the three sets, i.e. *NL* (Negative Large), *NM* (Negative Medium), *NS* (Negative Small), *PS* (Positive Small), *PM* (Positive Medium), and *PL* (positive large) in case of both dimensions.

Second Fuzzy System
In case of the second fuzzy system that controls the ICE and the generator we used triangle and trapezoid shaped membership functions (see Figs. 6~7). We used the conventional simple notation mode for the three sets, i.e. *Z* (zero), *PS* (Positive Small), and *PL* (positive large) in case of both dimensions.

3.5 Rule Base
First Fuzzy System
The first fuzzy block is a SISO fuzzy system of which rule base contains the six rules presented in Table 2.

Table 2. Rules of the first fuzzy block

	acc_brk_sat	q_e
1	NL	NL
2	NM	NM
3	NS	NS
4	PS	PS
5	PM	PM
6	PL	PL

Table 3 Rules of the second fuzzy block

	E_{brel}	q_m	q_g
1	Z	PL	PL
2	PS	PS	PS
3	PL	Z	Z

Second Fuzzy System
The second fuzzy block is a SIMO fuzzy system with two output dimensions. Its rule base contains the following three rules presented in Table 3.

4. Simulation and performance evaluation

In order to minimize fuel consumption and to take into consideration some other requirements a complex cost function (1) was defined as objective function for the tuning process.

$$J = \int_0^T \left(\sqrt{\left(\frac{B}{B^{\max}}\right)^2 + \left(\frac{e_{CO}}{e_{CO}^{\max}}\right)^2 + \left(\frac{e_{HC}}{e_{HC}^{\max}}\right)^2 + \left(\frac{e_{NOx}}{e_{NOx}^{\max}}\right)^2 + \left(\frac{\xi_j}{\xi_j^{\max}}\right)^2 + \left(\frac{E_{brel}}{E_{brel}^{\max}}\right)^2} \right) dt \cdot \frac{1}{\int_0^T dt}, \qquad (1)$$

where T is the simulation time, B is the fuel consumption of the ICE, e_{CO} is the CO emission of the ICE, e_{HC} is the HC emission of the ICE, e_{NOx} is the NOx emission of the ICE, ξ_j is the acceleration factor, E_{br} is the battery energy level. All components of the cost function were taken into consideration with equal weights.
The simulation was carried out for T=10 000 seconds. Figs. 8 and 9 show that the ICE was mainly used after t=2 108 s when the state of charge (SOC) E_{brel} fall below 0.7. In long term (between 2 108 s and 10 000 s) the relative SOC was kept between 0.64 and 0.68, which ensures a charge sustainability of the system. Fig. 9 (third row) presents that the driver block and the first fuzzy control block ensures a good tracking of the predefined driving cycle. After an initial fluctuation the value of the cost function stabilized around 0.03. Its final value became 0.03091.

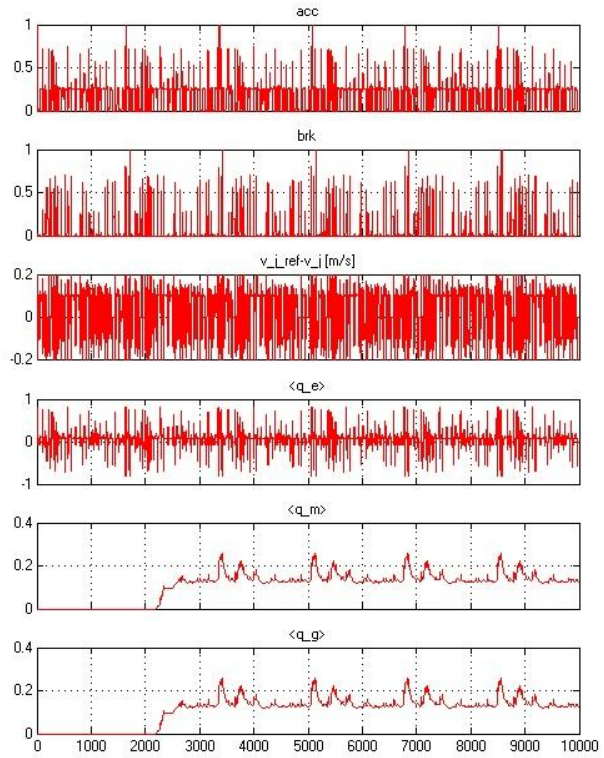

Figure 8. Input and output signals

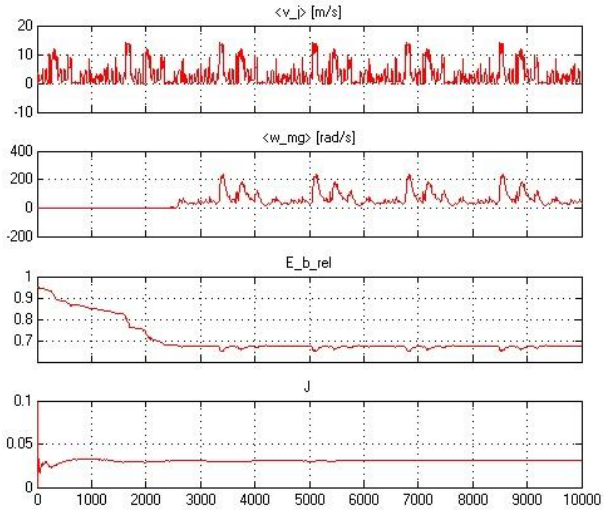

Figure 9. State signals

5. Conclusion

In this paper, a simple fuzzy logic based solution was presented for the controlling of the power management of a series hybrid vehicle. Our objective was to develop a controller that ensures a low level of harmful pollutant emission while the charge sustainability of the system is also ensured. To fulfil this demand a cost function was created and the parameters of the fuzzy control were optimized based on its value. In case of the applied driving cycle the developed system ensured a good solution.

Further research will consider other options regarding the applied HEV type, interpolation based fuzzy inference techniques (e.g. [6][8][11]) and automatic rules base generation and optimization methods (e.g. [21][1]). The research on the optimal weights of different factors taken into consideration in equation (1) is also subject to further research work.

Acknowledgement

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APPLICATION OF FUZZY PETRI NETS IN THE SPECIFICATION OF ADAPTIVE WEB-BASED SYSTEMS

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Abstract
Petri Nets provide the representation and analysis of process execution, concurrency and synchronization, and can also be used to represent logical inference rules. Fuzzy Petri Nets were introduced for fuzzy knowledge representation and reasoning. Various modifications of Petri Nets and Fuzzy Petri Nets have been applied in different fields such as knowledge representation, inference, learning and the description of multi-agent systems. A modification of the Fuzzy Petri Nets for the specification of adaptive systems, whose behavior depends on user behavior, is presented in this paper, emphasizing web-based learning systems.

Keywords:
Fuzzy Petri Nets, Adaptive Web-based Systems, Web-based Learning Systems

1. Introduction

Fuzzy Petri Nets [1] were defined for knowledge representation and reasoning in expert systems based on that Petri Nets offer an appropriate model for the representation of logical operations in an intuitive and visual way.
Numerous modifications have been made to the Fuzzy Petri Nets to increase their ability to model different tasks. Among these changes are the Adaptive Petri nets [2], which have not only the traditional advantages of the Petri Nets, but also have the learning ability of the neural networks. Other modifications were introduced in order to be applied in a specific field, such as the Dynamic Fuzzy Petri Nets [3], which were introduced to direct the teaching strategy of a web-based learning system.
In this paper we introduce Priority Fuzzy Petri Nets, a model that incorporates to the Adaptive Fuzzy Petri Nets improved capabilities of the Dynamic Fuzzy Petri Nets.
The article is organized as follows: first a brief introduction to Fuzzy Petri Nets and its modifications mentioned above is given (2), then we define the Priority Fuzzy Petri Nets (3), describe the algorithm for reasoning in the defined model (4), and show the dynamic characteristics of the model (5), finally some applications are discussed (6) and a combination of the Priority Fuzzy Petri Nets with Synchronized Petri Nets [4] is presented (7).

2. Fuzzy Petri Nets, Adaptive Fuzzy Petri Nets and Dynamic Fuzzy Petri Nets

Fuzzy Petri Nets (FPNs) [1] have been used for knowledge representation of expert systems. In [1] an FPN is defined as follows:

$$FPN = (P, T, D, I, O, f, \alpha, \beta)$$

where:

$P = \{p_1, p_2, \dots, p_n\}$	is the set of places;
$T = \{t_1, t_2, \dots, t_m\}$	is the set of transitions;
$D = \{d_1, d_2, \dots, d_n\}$	is the set of propositions;
$I: T \rightarrow 2^P$	is the input function which gives the input places of a transition;
$O: T \rightarrow 2^P$	is the output function which gives the output places of a transition;
$f: T \rightarrow [0,1]$	assigns a certainty value to each transition;
$\alpha: P \rightarrow [0,1]$	assigns a value of the [0,1] interval to each place;
$\beta: P \rightarrow D$	bijective function, which associates a proposition to each place.

A modified fuzzy Petri net called Adaptive Fuzzy Petri Net (AFPN) was introduced in [2]. AFPNs can represent knowledge given by Weighted Fuzzy Production Rules (WFPR). In [2] an AFPN is defined as follows:

$$AFPN = (P, T, D, I, O, \alpha, \beta, \delta, W)$$

where:

P, T, D, I, O, α, β	are the same as defined in FPN;
$\delta: T \rightarrow [0, 1]$	threshold function, which gives the threshold of each transition;
$W = W_I \cup W_O$,	

W_I: I → [0, 1] is the input weights function, which gives the weight of each input place (input arc)

W_O: O → [0, 1] is the output weights function, which gives the weight of each output place (output arc)

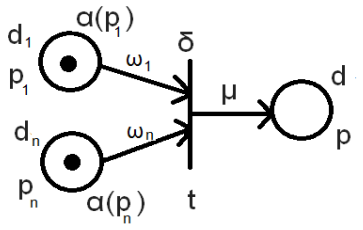
A general weighted production rule has the following form:

IF a THEN d (CF = μ), δ, W

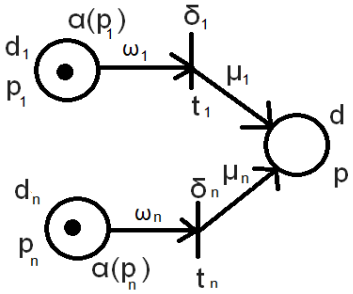
where:

- $a = <d_1, d_2, \dots, d_n>$ is the antecedent with one or more propositions (d_i $1 \le i \le n$) connected in conjunctive (AND) or disjunctive (OR) form;
- d is the consequent proposition;
- μ is the certainty factor of the rule;
- $\delta = <\delta_1, \delta_2, \dots, \delta_n>$ is the set of the thresholds of the propositions of the antecedents;
- $W = <\omega_1, \omega_2, \dots, \omega_n>$ is the set of the weights of the propositions of the antecedents.

Figure 1 shows the mapping of the WFPRs (conjunctive and disjunctive) into AFPNs. Note that a restriction is assumed for conjunctive rules, there is only one threshold for the rule. However, for disjunctive rules different values of μ can be given for the different transitions.



AFPN of a conjunctive WFPR



AFPN of a disjunctive WFPR

Figure 1. AFPNs of WFPRs

Another modified fuzzy Petri net called Dynamic Fuzzy Petri Net (DFPN) was introduced in [3] to provide more flexible learning sequences in Web Based Learning Systems (WBLS).

In a DFPN two types of input arcs are defined. The system first try to execute the transition using only the solid line arcs, and if it is not possible because the truth value of the proposition corresponding to these arcs is less than the threshold, then executes the transition using the dashed arcs too (the dashed arcs become solid arcs).

A dynamic fuzzy production rule (DFPR) has the form:

PR_i: IF $\alpha(p_j) \ge \delta_i$ THEN $PR_i = SPR_i$ ELSE $PR_i = DPR_i$

where:

SPR_i: IF dj THEN d_k (CF = μ_i)
DPR_i: IF d_j AND d_x THEN d_k (CF = μ_i)

The δ_i is the threshold value of the rule, SPR_i the static fuzzy production rule and DPR_i the dynamic production rule.

Figure 2 shows the DFPN which corresponds to the previous DFPR PR_i.

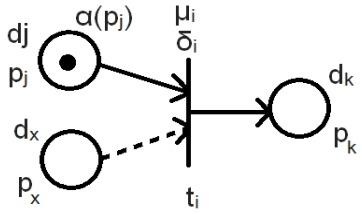


Figure 2. DFPN which corresponds to the DFPR PR_i.

3. Priority Fuzzy Petri Nets

Priority Fuzzy Petri Nets (PFPNs) are introduced here based on AFPNs and DFPNs.

PFPNs are AFPNs with priorities added to the transitions. Priorities are applied in reasoning with disjunctive rules. The input proposition of the transition with the highest priority is evaluated first, when necessary.

A PFPN is defined as follows:

PFPN = (P, T, D, I, O, α, β, δ, W, ρ)

where:

- P, T, D, I, O, α, β, δ, W are the same as defined in AFPN;
- ρ: T → [0,1] function which gives the priority of the transitions.

We will use the following definitions from [3]:

Definition 1.

a) The set of User Inputs:

$$P_{UI} = \{p \in P \mid {}^\bullet p = \varnothing\}$$

b) The set of interior places:

$$P_{int} = \{p \in P \mid {}^\bullet p \neq \varnothing \text{ and } p^\bullet \neq \varnothing\}$$

c) The set of Output places:

$$P_O = \{ p \in P \mid p^\bullet = \varnothing\}$$

Note: $P_{UI} \cup P_{int} \cup P_O = P$

Definition 2. The marking of a place p is the certainty factor of the token in it α(p).

Definition 3. A $t \in T$ transition with $I(t) = \{p_1, \dots, p_n\}$ is enabled if $\forall p_i \in I(t)$ $(1 \leq i \leq n)$, $\alpha(p_i) > 0$.

Definition 4. When $t \in T$ is enabled we can calculate a resulting certainty factor by the equation (1).

$$CF(t) = \begin{cases} \sum_{i=1}^{n} \alpha(p_i).\omega_{it}, if \sum_{i=1}^{n} \alpha(p_i).\omega_{it} \geq \delta(t) \\ 0, if \sum_{i=1}^{n} \alpha(p_i).\omega_{it} < \delta(t) \end{cases} \quad (1)$$

where ω_{it} is the weight of the input arc from p_i to the transition t

Definition 5. If $CF(t) \geq \delta(t)$ for $t \in T$, then transition t fires, and token transmission take places as described below:

a) $\forall p_j \in O(t) \mid {}^\bullet p = \{t\}$:

$$\alpha(p_j) = CF(t).\omega_{tj}$$

where ω_{tj} is the weight of the output arc from the transition t to the place p_j

b) $\forall p_j \in O(t) \mid |{}^\bullet p| > 1$ (p has more than one input transition), $\alpha(p_j)$ is calculated by equation (2).

$$\alpha(p_j) = \frac{\sum_{k=1}^{m} \omega_{t_k j}.CF(t_k)}{\sum_{k=1}^{m} \omega_{t_k j}} \quad (2)$$

where t_k (k=1,…,m) are the input transitions of p_j that fires and $\omega_{t_k j}$ is the weight of the output arc from the transition t_k to the place p_j

We add the following definition:

Definition 6. A $t \in T$ transition with $I(t) = \{p_1, \dots, p_n\}$ can be enabled if:

a) not enabled,

b) and $\forall p_i \in I(t)$ $(1 \leq i \leq n)$, if $\alpha(p_i) = 0$ then $p_i \in P_{UI}$,

c) and $\exists p_j \in O(t) \mid \alpha(p_j) = 0$.

This definition is introduced to select transitions that contribute to continue reasoning by asking for user input. In the reasoning algorithm presented below the criteria for the selection of one transition that can be enabled to continue reasoning is given.

4. Reasoning Algorithm for PFPNs

INPUT:
Certainty factors of a subset (possibly empty) of P_{UI} (User Inputs).

OUTPUT:
Certainty factors of a subset of the set of consequence propositions $P_{int} \cup P_O$.

STEPS:

1. Let $T_{toApply} = T$
2. Let $T_{enabled}$ = the set of current enabled transitions $T_{current}$ in T_{apply} according to definition 3.
3. If $T_{enabled} = \varnothing$, then let $T_{canBeEnabled}$ = {the transition in $T_{toApply}$ with the higher priority that can be enabled according to definition 6}, else let $T_{canBeEnabled} = \varnothing$.
4. Let $T_{current} = T_{enabled} \cup T_{canBeEnabled}$
5. Calculate certainty factors of the transitions in $T_{current}$ according to definition 4.
6. Make token transmission according to definition 5.
7. Let $T_{toApply} = T_{toApply} - T_{current}$
8. Go to step 2 and repeat the 2-8 dteps, until $T_{current} = \varnothing$ in step 4.

5. PFPNs and DFPNs

We can see that the PFPNs gives more flexibility than DFPNs to define dynamic rules. The PFPNs shown in Figure 3 describes de following DFPR, if $\rho(t_{i0}) > \rho(t_{i1}) > \rho(t_{i2}) > \dots > \rho(t_{in})$:

PR_i: IF $CF(t_{i0}) \geq \delta_{i0}$ THEN $PR_i = SPR_i$
ELSE IF $CF(t_{i0}, t_{i1}) \geq \delta_{i1}$ THEN $PR_i = DPR_{i1}$
ELSE IF $CF(t_{i0}, t_{i1}, t_{i2}) \geq \delta_{i2}$ THEN $PR_i = DPR_{i2}$
…
ELSE IF $CF(t_{i0}, t_{i1}, t_{i2}, \dots, t_{in}) \geq \delta_{in}$ THEN $PR_i = DPR_{in}$
where:
SPR_i: IF d_{i0} THEN d_i $(CF = \mu_i)$
DPR_{i1}: IF d_{i0} OR d_{i1} THEN d_i $(CF = \mu_i)$
DPR_{i2}: IF d_{i0} OR d_{i1} OR d_{i2} THEN d_i $(CF = \mu_i)$
…
DPR_{in}: IF d_{i0} OR d_{i1} OR d_{i2} OR … OR d_{in} THEN d_i $(CF = \mu_i)$

In the PFPN we can define different certainty factors for the n dynamic rules contained in PR_i using the weights of the output arcs, and the rule can be refined to meet our needs with the help of the weights of the input arcs.

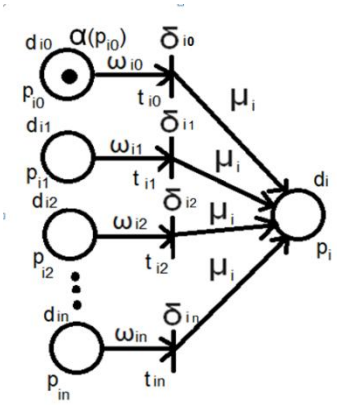


Figure 3. PFPN of a DFPR

If $p_{ij} \in P_{UI}$ $(0 \le j \le n)$, then the user will be asked first for the proposition d_{i0} which corresponds to the input place of the transition with higher priority. The used is asked for the proposition d_{ij+1} only if $\alpha(p_i)$ is 0 after the application of the transition t_{ij} and the corresponding token transition.

6. Some applications of the PFPNs

Three applications of the PFPNs for systems modeling will be presented here.

a) Modeling Adaptive Web-Based Systems

PNs can be used to model web-based systems associating the pages to places of the PNs and the transitions between pages to transitions in the PNs.
AFPNs can be used to express adaptive behavior of web-based systems. The system suggests the pages to visit next, ordering the suggested pages in decreasing order of its predicted certainty values. Two places p and p' are associated for each page p as is shown in Figure 4. The place p is the output place of the transitions to the page p and p' is a place to be evaluated during the interaction of the user with the page p ($p' \in P_{UI}$). However, p' must has a predicted $\alpha(p')$ value when the page p is presented which is used to calculate the predicted values $\alpha(p_1)$, $\alpha(p_2)$, …, $\alpha(p_n)$, where p_1, p_2, …, p_n are the pages suggested to visit next. When the user leaves the page p the real current value of $\alpha(p')$ is calculated, and the $\alpha(p_1)$, $\alpha(p_2)$, …, $\alpha(p_n)$ values are recalculated. If p_i $(1 \le i \le n)$ is the selected page, then $\alpha(p_i')$ has to be predicted, the simplest way is to make $\alpha(p_i') = \alpha(p')$.

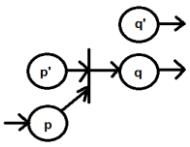


Figure 4. Modeling Adaptive Web-Based Systems

The prediction of the certainty values can be avoided if next pages suggestions are shown when the user finishes his work with the current page.
We can improve our model by introducing dynamicity using FPFNs.

b) Evaluation systems

An evaluation system has an initial marking with the certainty values of all of the places in PUI (correctness values corresponding to the answers to questions, solutions to problems, etc.), and with the execution of the reasoning algorithm the result of the evaluation is obtained.
AFPNs or PFPNs can be used to model the evaluation system and due to the learning ability of AFPNs the system can learn the fuzzy knowledge which leads to good results.

c) Web-Based Learning Systems

The teaching strategy of the web based learning systems can be modeled similarly to the adaptive web-based systems.
In web-based learning systems a place $p \in P_{UI}$ corresponds to a lesson. In this type of systems prediction of certainty values is not necessary because the teaching strategy shows the possible next lessons when the current lesson is finished.
PFPNs is a good selection to model the teaching strategy because it combines the advantages of AFPNs and DFPNs.
Dynamic rules are used in web-based learning systems to provide learner with alternative lessons (alternative materials) when he obtain poor results with the current lesson.

7. Combining PFPNs with Synchronized Petri Nets

Synchronized Petri Nets (SyPNs) were introduced in [4] as a Recursive Petri Net (RPN) based formal specification model for multi agent planning able to model local and remote interactions.
Figure 5 shows an example taken from [4] of modeling multi agent planning by means of SyPNs. In the figure the rectangles with simple borders corresponds to elementary transitions, while the rectangles with double borders corresponds to abstract transitions. The elementary transitions represent the tasks to be performed by the agents, and are included in the synchronization points SP_1, SP_2, SP_3 and SP_4.

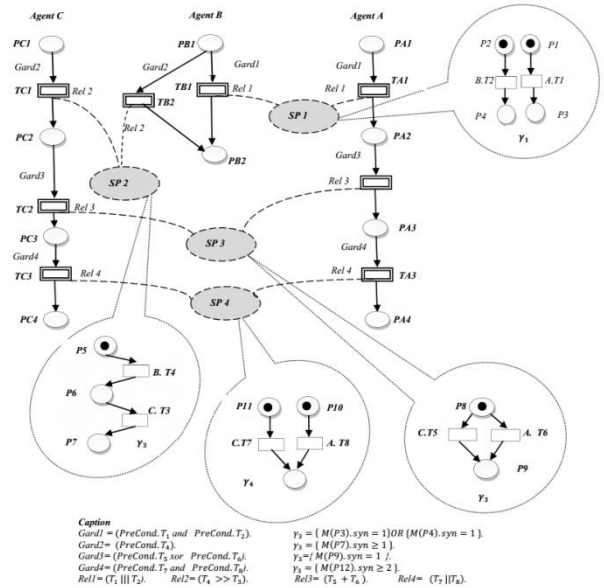


Figure 5. Modeling multi agent planning by means of SyPNs (figure taken from [4])

We can use SyPNs to model the multi agent system and PFPNs to model the tasks performed by the agents.

8. Conclusion

Priority Fuzzy Petri Nets was introduced, a model that incorporates to the Adaptive Fuzzy Petri Nets improved capabilities of the Dynamic Fuzzy Petri Nets. The Priority Fuzzy Petri Nets' reasoning algorithm was given and it was shown some applications of Priority Fuzzy Petri Nets in Adaptive Web-based Systems and particularly in Web-Based Learning Systems. Priority Fuzzy Petri Nets was proposed as a good candidate for modeling the tasks performed by the agents in a multi agent system modeled by means of SyPNs.

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TRAJECTORY BUILDING METHOD FOR AUTONOMOUS MOBILE ROBOTS

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Abstract
In this paper we present an indoor area exploration and trajectory building method for autonomous mobile robots. We assume that the robot is equipped with a camera sensor in order to detect its local environment. The camera is able to capture the flat and obstacle free area, which contains homogeneous square shaped floor tiles, in front of the robot. Our method executes intensity based segmentation on the captured scenes which allows detecting the edges and corners of the floor-tiles (landmarks). Using these landmarks the robot is able to navigate in the environment. The landmarks are labelled in each scene in order to track them during the algorithm execution. Moreover we know that the area in front of the robot is a two dimensional plain, thus the undistorted plain and landmark points can be calculated. Due to this, the robot is able to build a trajectory from the transformed landmarks based on a single camera sensor without any other kind of sensors.

Keywords:
mobile robot, trajectory building, image processing

1. Introduction

Unknown environment exploration and map building in the field of mobile robotics still has attracted a lot of research interest in these days. Several methods in the literature use multiple robots solution to accomplish the area exploration task [1][3-4]. An important task during the algorithm execution is the trajectory building, which provides the travelled path of robot. The robot registers its turns and displacements periodically, and this information produces the trajectory. A perceptible solution is to use odometry, which is a method that calculates the position and heading angle of a mobile robot using encoders attached to the wheels of the robot. Adapting only odometry is not accurate enough; at least a compass sensor is necessary in order to get an accurate trajectory [1]. This paper introduces camera sensor based navigation for indoor environments. We assume that the environment is obstacle free and contains a square grid shaped floor, thus the robot is able to detect the edges and corners of the rectangular grid-net (landmarks).

Our paper is organized as follows. In the next section our navigation and trajectory building method is introduced. Section 3 shows the experiments and results with the proposed algorithm. Finally, section 4 presents our conclusions.

2. The proposed navigation method

2.1. Camera calibration and projection matrix

Before the robot executes our image processing method the camera has to be calibrated so that the interior camera parameters (camera focal lengths and optical centres) and the camera lens distortion become known. In our case the calibration is indispensable since we want to detect straight lines and the images have to be rectilinear during the algorithm execution.
We assumed that the camera sensor captures frames about the local area in front of the robot, which is a two dimensional plain. This assumption allows calculating a view from above with a projection matrix. After this perspective affine transformation the lines is going to be straight and distortionless, thus the robot is able to orientate itself in the environment with a camera sensor.

2.2. Processing an image scene

The flow of one image scene processing is shown in Figure 1. First, the coloured image is converted into greyscale image since the scene is pre-processed by edge detection based segmentation. Canny edge detection [6-7] is executed on the greyscale image, thus the borders of tile grid are appeared in the output. Canny is an edge detection method, which enhances and localizes the intensity changes and suppresses the homogeneous regions in the given image. One of the many benefits of this method is the single edge response which means that one edge appears only once in the output. The single response is provided by the method of Hysteresis, which uses two threshold values. Choosing the proper threshold values of Hysteresis influences the result of edge detection, for this reason the best high and low threshold is chosen based on the environment properties. In our algorithm these values are

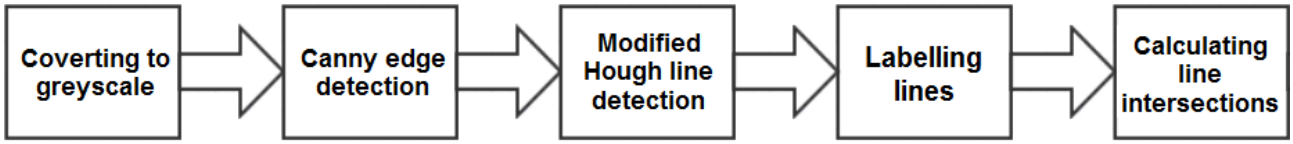


Figure 1. The flow chart of processing an image captured by the robot.

initialized dynamically with the solution of Fang [10], where threshold values are calculated by the Otsu [5] method right before the robot starts working in the environment. We assume that the intensities of greyscale image could be separated into two classes thus the Otsu method is able to perform the optimal separating threshold between the two classes. The original article [10] uses Otsu method in order to determine the high Canny threshold and the low one is chosen to be the half of the high value. We modified the high threshold value to 0.7 times the value used by Fang, and the low value is also chosen to be half of the high threshold. Using this method a detailed edge detected image is provided, which contains some detection errors as well. The following processing method works well on edge detected image, which is rich in detail and it is not sensitive for detection errors.

After the edge detection we use the Hough transform [8] to enhance the line segments and get geometrical information from the image, which is stored in polar coordinates. The parameters r and Θ represents a line, where r is the radial coordinate, Θ is the angular coordinate in radian. The Hough transform also uses a threshold value since in this case we applied a high vale in order to select significant lines on the image. This transform do not provide single response like the Canny method, and the output is an ordered array, which contains the best candidates above the threshold value. These candidates are supposed to be lines with similar parameters. We extended the line selection and execute this procedure on the ordered Hough output array as follows:

- add the first line the result array;
- repeat the following for all of the other lines in the array:
  - if the parameters of the current line are close to the parameters of one of the lines in the result array then do not take into consideration,
  - else add it to the result array

Finally the single response is available so the objects of the image are easy to store and track in the further images.

2.3. Data association

The found line objects have to be labelled and stored in order to identify and track them in the further image scenes. The projection matrix becomes really important at this point since the identification is based on the transformed objects.

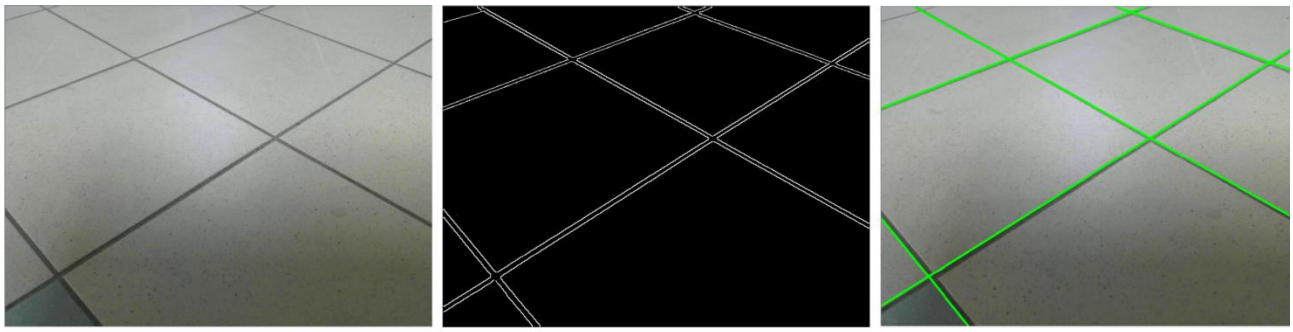
Before labelling them, the number of the lines is reduced so that the line segments of the floor grid are selected, and the other segments are discarded. We propose the following solution to separate the two kinds of segments: we assume that in the first detection only the line parts of grid appear. In this case the transformed lines are divided into two classes by the Θ line parameter. Centre point of classes is determined by K-Means [9] method, thus the lines, which are not part of the grid, are not taken into consideration during the further processing. Another benefit of this method is that the robot is able to start the area exploration from any position.

At the first labelling each line is assigned with a unique label and the transformed line parameters are stored. After this, we use the nearest neighbour concept (with Euclidean metric) in order to identify the lines. Thus we calculate the distances among previous and current detected lines and if the actual calculated distance is below a predetermined constant the line is identified. If a line cannot be associated, then we search for a new line in the scene. It is also possible that a previously detected object cannot be seen any more in the current image since the robot go past it.

Finally, the robot calculates the intersections of the detected lines and labels and tracks them with the same method that was used for the lines.

2.4. Trajectory building

During the area exploration the robot stores its displacements in certain sequential time intervals in order to build a trajectory. Given that the robot continuously processes the captured images, and



a b c

Figure 2. (a) Original captured image; (b) result of the Canny edge detection; (c) detected line objects by Hough transform

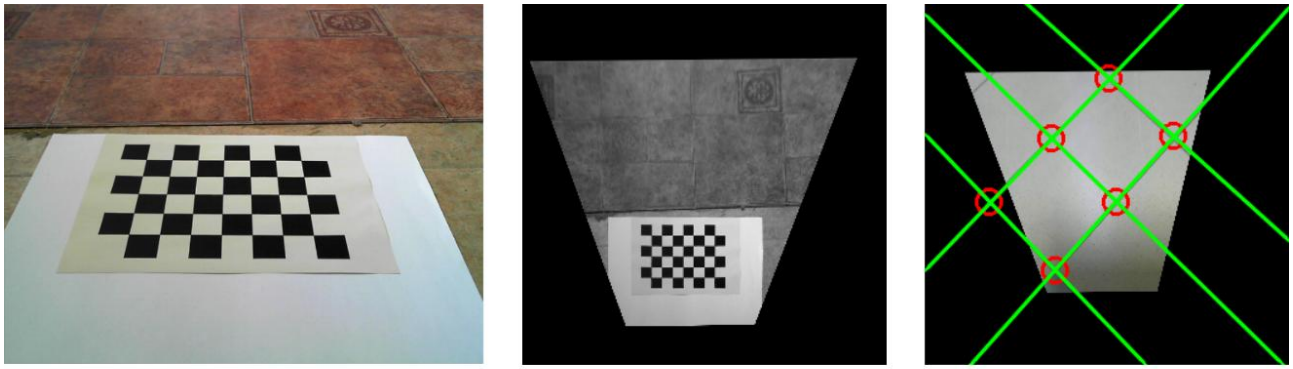


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Figure 3. (a) Chessboard calibration table in front of the robot; (b) calculated projection plane; (c) the result of the proposed Title of the Figure

that the landmarks of the environment are labelled and tracked, the trajectory building will be an easy task. In our solution the surrounding of the camera's optical centre is analysed since this area is the sharpest part of the captured frame. This has an important effect to the result of image processing methods. The video frame is sampled during the algorithm execution and the four nearest labelled intersection points are chosen in order to measure the robot displacement. The displacement vector is calculated as the difference of the current and the previous location of intersections on the image. The four calculated vectors are averaged in order to reduce the error of observation. Finally the trajectory is obtained as the sequence of these displacement vectors.

3. Experiments and results

In the experiments we used a Microsoft LifeCam HD camera with a resolution of 640x480 and fixed camera focus. The camera was situated in front of the robot and able to detect the frontal environment of robot.

First we determined the projection transformation matrix with the chessboard calibration table, which is shown in Figure 3. This transformed plane becomes rectilinear since the distorted lines in the original image are adapted into an undistorted plane and the lines will be straight. Thus, measuring the turns and displacements of robot is executable based on the transformed plane.

We did several experiments in order to test our trajectory building method. In our experiments the robot performed 3 and 5 meters long linear movement without any rotations, and the robot was calculating the displacement during the algorithm execution. One of the 5 meter experiment's results is shown in Figure 4. It can be seen that the current version of the proposed method worked fairly inaccurate since some detection errors. Thus, in the future we plan minimize the errors which come from inaccurate detection.

4. Conclusions and future work

We introduced a possible solution to explore indoor environments with autonomous mobile robots. In our solution an image processing based method is used, which provides a sufficient result when the floor is covered with square grid shaped floor tiles.

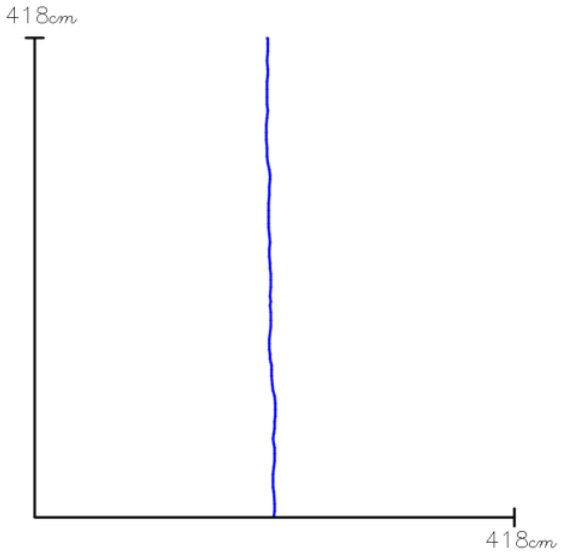

Figure 4. The result trajectory after a 5 meters long linear movement.

In the future we plan to equip our robot with motor encoders in order to combine our image processing method and odometry for getting more accurate trajectory results.

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MODELING UNCERTAINTY FOR STOCHASTIC OPTIMISATION

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Abstract
Strategic decision making generally requires managing uncertainty. In this paper we demonstrate the application of elliptical copula models namely Gaussian and Student's t-copulas for stochastic optimization problems. We present numerical examples, basic algorithms and computational studies.

Keywords:
Scenario construction, statistical model, copula, stochastic optimization

1. Introduction

Handling uncertainty is one of the most challenging tasks in decision support, just as it is in everyday life. Patterns of behaviour that prove expedient in everyday life often pan out in decision support as well. For example, Wodehouse in his inspiring book [16] advocates 'a wholesome pessimism, which, though it takes the fine edge off of whatever triumphs may come to us, has the admirable effect of preventing Fate from working off on us any of those gold bricks, coins with strings attached, and unhatched chickens, at which ardent youth snatches with such enthusiasm, to its subsequent disappointment.' Advancing age, as Wodehouse points out, brings forward caution. But isn't there a faster way of developing skills in decision making under uncertainty? Of course there is, though not as sure as the natural one. Statistical decisions have been investigated since the middle of the seventeenth century (initial inspiration having come from gambling, a favourite pastime back then.)

Specifically, stochastic optimization models have been worked out in the past century. A comprehensive treatment of these classic models can be found in the monographs Kall and Wallace [17], Prékopa [18], Birge and Louveaux [19]. Important fields of application are energy and water management, transportation, and finance. Emerging ones are healthcare, agriculture and sustainable development. Stochastic optimization models are well suited to describe e.g. smart grids [1] and transportation networks [2], and specifically support risk management, like the techniques discussed in [3]. Real-life applications inspire the development of new models and solution approaches.

In order to formulate stochastic models, we should be able to measure risk, or, at least, to compare the (random) outcomes of different decisions. The concept of stochastic dominance has been created for this latter purpose. Its invention was inspired by earlier work of Hardy, Littlewood and Polya [20]. In economics, stochastic dominance was introduced in the sixties of the past century. Quirk and Saposnik [21] considered the first-order stochastic dominance relation, and demonstrated its connection to utility functions. Second-order stochastic dominance was brought to economics by Hadar and Russel [22]. A detailed discussion can be found in Whitmore and Findlay [23], and a survey in Levy [24]. Stochastic optimization models with stochastic dominance constraints were first formulated by Dentcheva and Ruszczyński [25]. A dominance measure was proposed in Roman, Darby-Dowman and Mitra [26], and an enhanced measure was developed in [27].

The way of representing randomness is crucial in the formulation of stochastic optimization models. Sampling of the random parameters is often applied in practice, and the estimators of the optimal value and the optimal solution are well investigated. A survey can be found in Shapiro [4], Shapiro and Philpott [28]. Ongoing studies aim at modelling the dependence structure of random variables. Once the random parameters are well characterized, we can generate scenarios, i.e., possible realizations of the random parameters. A large scenario set can then be used to formulate a decision problem. Alternatively, the outcome of a decision can be tested on a scenario set. As an application of the latter approach, we refer to [1], discussing stability estimations of smart grids.

In the past years, we tried different methods of scenario generation. Using different methods, we built different scenario sets, formulated the corresponding decision problems, solved them, and compared the respective optimal solutions. In course of this project, we used a simple but nontrivial stochastic programming model described in [11]. It is about maximizing the dominance measure of [27] with respect to linear constraints. We used the same solver that was applied in the computational study of [11]. We gratefully acknowledge that this solver was developed at CARISMA, the Centre for the Analysis of Risk and

Optimisation Modelling Applications at Brunel University, London.

2. Modelling randomness

The objective of the present study is to describe the collective behaviour of random variables and to adjust the model to the observed data. One of the main problems in the field of multivariate modelling is the description of the dependence structure. To automate the multivariate scenario generation in this paper we use Monte Carlo techniques [3,5,6] because the total number of the scenarios is very large, close to a million. The Monte Carlo sampling with copulas is well documented in books and review part of several papers see, e.g.,[3, 5, 6,14] To apply Monte Carlo techniques, we need multivariate distribution functions. These are obtained through a calibration process which uses the realworld data. The copula method is a realistic way of linking univariate marginal distributions to a joint multidimensional distribution. Theory, application and details of the copula functions can be found several text books, see, e.g., [3, 5, 6, 7, 8]. The calibrated distribution function used for Monte Carlo conditional sampling. The good sampling procedure is very important because it is used for feeds scenarios generation the stochastic programming optimizer.

3. Copula method

In our former studies [11, 12, 13], we applied normal copulas and different marginal distributions to generate a dependent multivariate distribution. We find that the solution is improved by using normal copula based scenario generators [11]. The model shows considerable robustness and it was not very sensitive to data perturbations. Representing the possible realizations of random events, we generated a large number of scenarios. In our last paper in the TEAM Conference series we constructed a Gaussian copula-based statistical model, and compared this to a simplified model which assumed that the random variables were uncorrelated [13]. In a numerical study, we used weekly stock returns and selected optimal portfolios under a risk constraint. The structure of the optimal solution proved sensitive to the description of the dependence. This observation raises the question of how to construct an adequate dependence model. A natural way to extend the Gaussian copula model is the application of the Student's t-copula because the t-copula is generalization of the normal copula.

The application of copula methods has become popular for the description of the co-dependence structures of multidimensional random variables. In this paragraph we give a short description of the copula methodology, and basic definitions of the Gauss copula and the Student's t-copula. A copula is a cumulative probability function. The approach is based on Sklar's seminal works [9, 10] which declares that every *n*-dimensional distribution function *F* can be constructed using copula functions *C* uniquely if the marginals F_i are continuous functions:

$$F(x_1, \dots, x_n) = C(F_1(x_1), \dots, F_n(x_n))$$

The dependence structure is determined by the type of copula function used, and its parameters. The marginal distributions can be selected arbitrarily according with the applied model. This flexibility allows freedom in model construction. The specification of the marginals (type of distribution and its parameters) and of the copula function can be separated during model calibration.

One of the most practical copulas is the normal copula, derived from the multidimensional Gaussian distribution. The Student's t-copula associated with the multidimensional Student's distribution. Our former studies [11, 12, 13], we applied normal copulas and different marginal distributions to generate dependent multivariate distribution. The description of an *n*-dimensional normal copula contains *n(n-1)/2* pair governing parameters, which are not the "classical linear" correlation coefficients.

The normal copula belongs to the elliptical copula family and it can be represented in the following form see, e.g., [3, 5, 6, 7, 8,14]:

$$C_{\Sigma}^{Gauss}(u_1, \dots, u_n) = \Phi_{\Sigma}\left(\Phi^{-1}(u_1), \dots, \Phi^{-1}F_n(u_n)\right)$$

where Φ^{-1} is the inverse of the standard one-dimensional Gaussian distribution function and Φ_{Σ} is the *n*-dimensional standardized normal distribution function with expectation vector 0 and correlation matrix Σ (which is a positive definite and symmetric matrix and the diagonal elements are equal to one). The Monte Carlo conditional sampling also well documented textbooks and review see, e.g.: [3, 5, 6, 8, 14]

The above mentioned Gaussian copula does not adequately describe the joint extreme values which are often observed real-world data. In the case of the Gaussian copula, the dependence is reflected only via pair correlation parameters. The t-dependence structure can result extreme co-movements regardless from the marginal distributions.

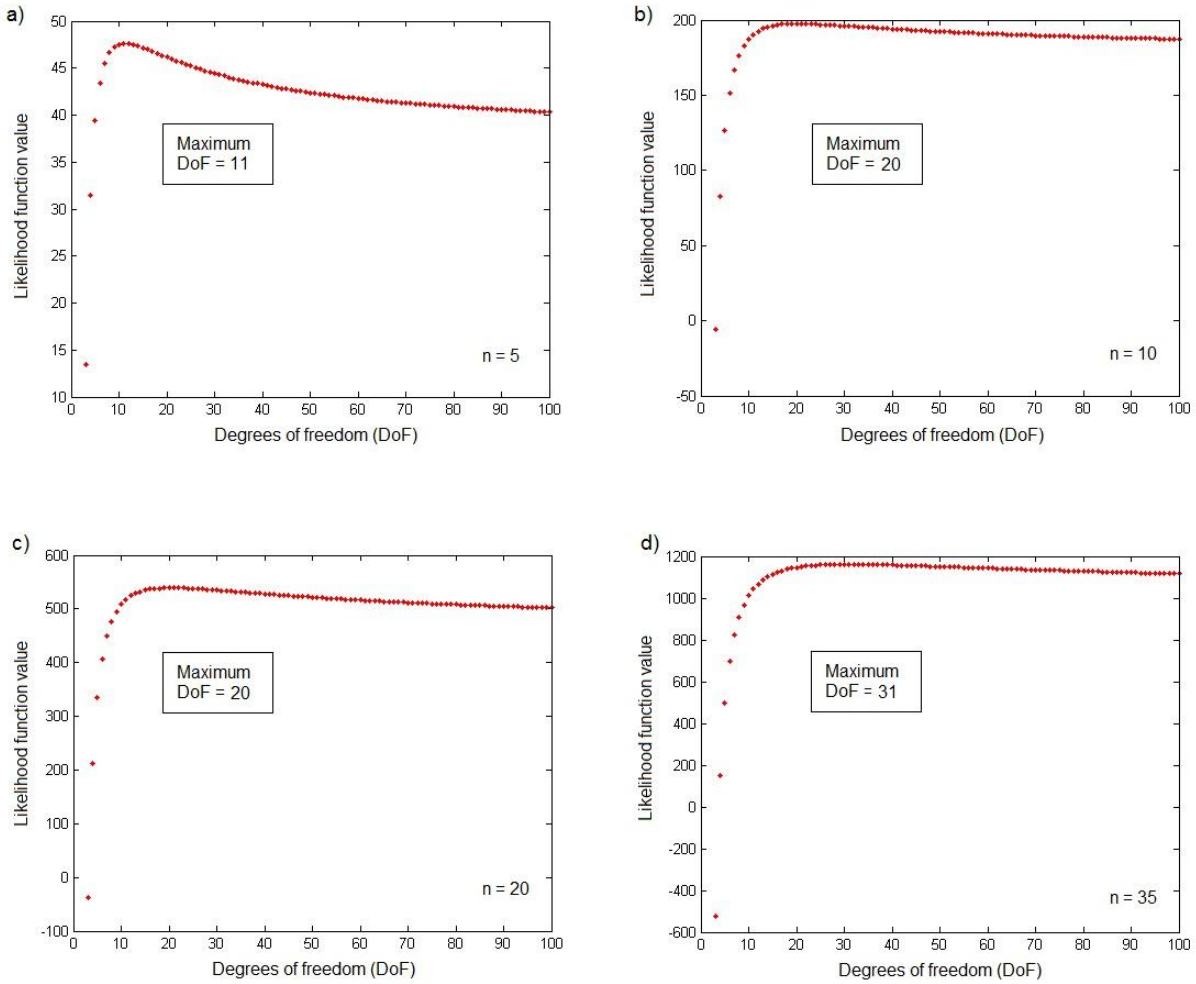

Figure 1. Examples of likelihood functions for degrees of freedom (DoF) of the Student's t-copula (a) n=5, (b) n=10, (c) n=20, (d) =35, n means the size of the portfolio

Our next extended model linked the random variables by t-copula. The Student's t-copula is driven by the pair correlations the same way as the normal copula is, but there is a new parameter, namely the degree-of-freedom DoF or ν. The above mentioned parameter represents the collective tail dependence of the *n* random variables. By increasing the value of the DoF parameter, we decrease the probabilities of the extreme co-movements, and this results smaller difference between the normal copula and the t-copula. The limit of the t-copula DoF --> ∞ corresponds the normal copula. The multivariate Student's t-copula is the copula of the multidimensional t-distribution see, e.g., [3, 5, 6, 7, 8, 14] and can be written as

$$C_{\nu,\Sigma}^{t}(u_1,\dots,u_n) = \mathrm{t}_{\nu,\Sigma}\left(t_\nu{}^{-1}(u_1),\dots,t_\nu{}^{-1}(u_n)\right)$$

where $t_\nu{}^{-1}$ is the inverse of the one-dimensional t-distribution function with ν degrees (DoF) of freedom and $\mathrm{t}_{\nu,\Sigma}$ is the multidimensional standardized Student's t-distribution with correlation matrix Σ and with ν degrees of freedom. A single parameter, namely the degree of freedom (DoF), determines the common tail dependence of the components.

The calibration and Monte Carlo conditional sampling methods which we used in this paper are well documented, see, e.g., [3, 5, 6, 7, 8, 14]. The estimation of the correlation matrix of the above mentioned two elliptical copulas are based on the empirical rank correlations. In the case of Gaussian copula we use the Spearman's rho, and in the case of t-copula we use the Kendall's tau for calibration. The Student's t-copula DoF parameter was determined by maximizing the log-likelihood function of the t-copula density [3, 15]. (see Figure 1.)

4. Computational results

The more stocks we included in the model, the larger (DoF) parameter we observed (see Figure 2.).

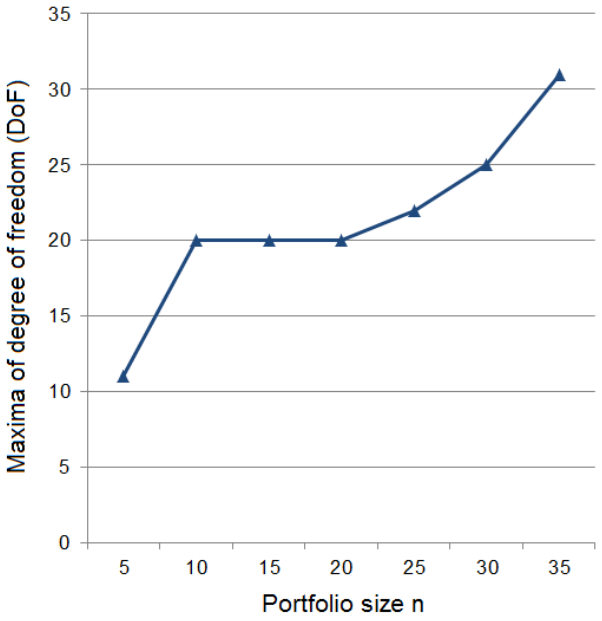

Figure 2. The graph shows the maxima of degrees of freedom (DoF) as a function of the portfolio size, n

Generally, the difference is small between normal copula and t-copula if the DoF parameter is high. In our numerical experiments, we observed relatively large and increasing degrees of freedom parameters, especially in case the number of the stocks was large.
The calibrated Student's t-copula was close to the Gauss copula, so the stochastic solver gave very similar results.

Acknowledgement

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ON FREE AND NONFREE DIRICHLET-VORONOI CELLS

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Abstract
The parallelotope P is a convex polytope that tiles the space in a face to face way. The vector $\boldsymbol{z}$ is called free if the Minkowski sum $P + S(\boldsymbol{z})$ is again a parallelotope, where $S(\boldsymbol{z})$ is a segment of the direction $\boldsymbol{z}$ and of the length z. A parallelotope is called free, if it has free vectors. The Dirichlet-Voronoi cell is a special kind of the parallelotope. V. Grishukhin proved that the Dirichlet-Voronoi cells of the dual root lattice E_6^* and infinite series of the lattices D_{2m}^+, $m \geq 4$ are nonfree in all directions. In this paper I prove that the root-lattices are free, except E_8.

Keywords:
Parallelotope, free parallelotope, Minkowski sum, Dirichlet-Voronoi cell

1. Introduction

The parallelotope P is a convex polytope that fills the space face to face by its translation copies without intersecting by inner points. The centers of the parallelotopes form an n-dimensional lattice. An n-dimensional parallelotope is called primitive if exactly $n+1$ adjacent parallelotopes meet in each vertex. B. A. Venkov and later P. McMullen proved the following important theorems for parallelotopes. A. D. Aleksandrov in [1] simplified Venkov's proof.

Theorem 1. (B. A. Venkov [31], P. McMullen [23])
The polytope P is a parallelotope if and only if
(i) P is centrally symmetric
(ii) each facet of P is centrally symmetric
(iii) the 2-dimensional orthogonal projection along any $(n-2)$-face of P is either a parallelogram or a centrally symmetric hexagon.

The edges of the parallelogram and the centrally symmetric hexagon of the above property (iii) are the projections of $(n-1)$ facets of P. These facets form a 2- and 3-belt, respectively.
At first we discuss briefly the results of the classification of parallelotopes. Two parallelotopes in the plane were already well-known in the antiquity: the centrally symmetric hexagon (primitive) and the parallelogram (not primitive).
E. S. Fedorov in [12] gave 5 combinatorically different parallelotopes in 3-dimension, among which the truncated octahedron is primitive while the others are not primitive, namely the elongated octahedron, the rhombic dodecahedron, the hexagonal prism and the cube. B. N. Delone [5] found 51 different types of the 4-dimensional parallelotopes. M. I. Shtogrin gave the missing 52nd in [25]. 17 of these are zonotopes and the 35 others are the regular 24-cell and the Minkowski sum of this with some zonotope. An n-dimensional zonotope in E^n is the vector sum of m line segments, in other words, it is the image of a regular m-cube under some orthogonal projection. Further results can be seen in [22]. Out of these types three are primitive. S. S. Ryshkov and E. P. Baranowskii [24] found 221 primitive 5-dimensional parallelotopes, which were completed by P. Engel and V. Grishukhin [10] with another one. P. Engel in [8] and [9] gave 179372 combinatorically different types of 5-dimensional parallelotopes.
It is easily seen that the set $\{parallelotope, <\}$ is partially ordered with maximal and minimal elements. Actually, consider the parallelotopes P and Q and the relation $<$. There is $P < Q$ if and only if there exists a direction $\boldsymbol{z}$ for which $P + k\boldsymbol{z} = Q$, where Minkowski sum is denoted by $+$. In this case P is called the contraction of Q and Q is the extraction of P. Denote by $S(\boldsymbol{z})$ the segment of the direction $\boldsymbol{z}$ and of the length z. V. Grishukhin [15] called the vector $\boldsymbol{z}$ *free* if the Minkowski sum $P + S(\boldsymbol{z})$ is again a parallelotope. A parallelotope is called *free*, if it has free vectors. An element is maximal if it cannot be extracted in a non-trivial way, i.e. there is no parallelotope of which it can be contracted. An element is minimal if it cannot be contracted. In 3-dimension, the maximal element is the primitive truncated octahedron from which you can get all parallelotopes, using contractions. The minimal element is the cube (see [4] or [21]). In 4-dimension there are 4 maximal elements but only 3 of them are primitive. Using contractions, 2 minimal elements are found. From these two minimal elements you can get all parallelotopes by extractions ([2], [14], [26]). It is clear that from the 3 primitive elements you can't get the all parallelotopes only with contractions.
P. Engel obtained the 5-dimensional parallelotopes from primitive parallelotopes by contracting and extracting of the obtained minimal elements, respectively. Unfortunately, in general not every parallelotope can be obtained such way because by theorem 13 the DV cell of the lattice E_8 cannot extract in any direction, further it is a parallelotope of zero width in each direction, thus it cannot

contract. So there is a non-primitive maximal element, which is also minimal and cannot be obtained from primitive element in any way, i.e. the DV cell of the lattice E_8 is nonfree. V. Grishukhin [15] proved that the Dirichlet-Voronoi cells of the dual root lattice E_6^* and infinite series of lattices D_{2m}^+, $m \geq 4$ are nonfree in all directions.
The concept of the Dirichlet-Voronoi cell was introduced by G. L. Dirichlet [6] and G. F. Voronoi [33]. Voronoi polytope and Voronoi cell are also used instead of Dirichlet-Voronoi cell in higher dimensions. We use shortly DV cell in this paper.

Definition 1.
Let us give a discrete point set L in the n-dimensional Euclidean space E^n. The DV cell of a point P_i of the set L is the set of points which are at least as close to point P_i as to any other point P_j of the set L.

If the point set L is a lattice it is clear that any two DV cells are translated copies of each other and any cell and its $(n-1)$-dimensional faces (called facets) are centrally symmetric convex bodies. The DV cells of a lattice form a lattice tiling, that is, their union covers the space and their interiors are mutually disjoint. This tiling is face to face. In this paper we investigate only the DV cells of lattices so denote the n-dimensional lattice and the DV cell of the point P by L^n and by DV^n, respectively. Classical problems of DV cells can be seen for example in [3], [16], [18], [19].
By the above the DV cell is a special parallelotope. The converse statement is the Voronoi's conjecture. G. F. Voronoi asked whether each parallelotope is the affine image of a DV cell. In [33] and [34] he proved the conjecture for primitive parallelotopes. O. K. Zsitomirszkij [35] extended G. F. Voronoi's proof to $(n-2)$-primitive parallelotopes, i.e. when each belt of the parallelotope is 3-belt. P. McMullen [22] proved the conjecture for zonotopes. R. M. Erdahl gave another proof for this in [5].

2. Parallelotopes

B. A. Venkov [32] introduced the concept of a parallelotope of non-zero width in the direction of a k-subspace X^k. A parallelotope P has non-zero width along X^k if the intersection $P \cap (X^k + \boldsymbol{a})$ is either k-dimensional or empty for every translation vector $\boldsymbol{a}$.

Theorem 2. (B. A. Venkov [32])
Let an n-dimensional parallelotope P be of non-zero width along X^k. Then
(i) the projection of P along X^k is a parallelotope (of dimension $n-k$)
(ii) the lattice vectors $\boldsymbol{t}_i$ related to the facets F_i which are parallel to X^k generate an $(n-k)$-dimensional lattice spanned by a space X^{n-k} which is transversal to X^k.
For $k=1$, the k-subspace X^k is a line. The direction of this line is given by a vector $\boldsymbol{z}$, so the z width of a parallelotope P along $\boldsymbol{z}$ is the minimal length of the intersections of lines parallel to $\boldsymbol{z}$ with P. If this minimal length is equal to zero then a parallelotope P is of zero width in the direction $\boldsymbol{z}$. V. Grishukhin proved that P has non-zero width in a direction $\boldsymbol{z}$ if and only if P has a closed edge zone parallel to $\boldsymbol{z}$ and P is the Minkowski sum of a segment $S(\boldsymbol{z})$ and a parallelotope P' of zero width in the direction $\boldsymbol{z}$, i.e. $P = P' + S(\boldsymbol{z})$. Thus the following theorem holds:

Theorem 3. (V. Grishukhin [14])
For any parallelotope exactly one of the following statements holds:
(i) it is a zonotope or
(ii) it is a parallelotope of zero width in any direction or
(iii) it is the Minkowski sum of a zonotope with a parallelotope of zero width in any direction.

The Minkowski sum $P + S(\boldsymbol{z})$ is not necessarily a parallelotope. The following theorem gives necessary and sufficient conditions for this sum to be a parallelotope.

Theorem 4. (V. Grishukhin [13], M. Dutour [7])
The following assertions are equivalent for a parallelotope P:
(i) the Minkowski sum $P + S(\boldsymbol{z})$ is a parallelotope
(ii) the vector $\boldsymbol{z}$ is orthogonal to the normal vector of at least one facet of each 3-belt of P.

3. Projection of parallelotopes and DV cells

Definition 2.
The shadow boundary of a parallelotope P in a direction $\boldsymbol{z}$ consists of all boundary points $\boldsymbol{x}$ of P for which the line $\{\boldsymbol{x} + k\boldsymbol{z} | k \in R\}$ is a support line of P. (There is no point of the line $\{\boldsymbol{x} + k\boldsymbol{z} | k \in R\}$ belonging to the interior of P).

It is well known that the shadow boundary of a convex polytope is the union of its some closed $(n-1)$- and $(n-2)$-dimensional faces. If the parallelotope $P + S(\boldsymbol{z})$ is of nonzero width in a direction $\boldsymbol{z}$ then the shadow boundary contains only $(n-1)$-facets which are called facets parallel to $\boldsymbol{z}$ by B. A. Venkov. As a generalization of this consider the following definitions. The introduction of these definitions is detailed in [20].
Denote by F_i a facet of the parallelotope P and by $\boldsymbol{t}_i$ the lattice vector connecting the center of the parallelotope P with a parallelotope P_i, where P and P_i are adjacent by the facet F_i. We name this lattice vector as the *relevant vector* of F_i.

Definition 3.
Let P be a parallelotope and $F(n-2)$ one of its faces of the dimension $(n-2)$. Then there exist two facets of P, say $F_1(n-1)$ and $F_2(n-1)$ with relevant vectors $\boldsymbol{t}_1$ and $\boldsymbol{t}_2$, respectively, which contain this face. If $F(n-2)$ determines a 2-belt then we call the lattice vector $\boldsymbol{t}=\boldsymbol{t}_1+\boldsymbol{t}_2$ the its generalized relevant vector. (This is a lattice vector of the lattice of translations associated to $F(n-2)$.)

We note that there is no generalized relevant vector of the $(n-2)$-face in a 3-belt.

Definition 4.
Let P be a parallelotope with the lattice L^n and $\boldsymbol{z}$ be a given direction of the space. We denote by $L_{\boldsymbol{z}}$ the sublattice of L^n spanned by those relevant or generalized relevant vectors of P whose corresponding faces are maximal ones (with respect to the face-lattice of the parallelotope) of faces belonging to the shadow boundary of a direction $\boldsymbol{z}$. We shall say that this lattice is the Venkov lattice associated to the direction $\boldsymbol{z}$.

Further on, we use the following statement on the connection between the projection and the extraction of a parallelotope.

Theorem 5. (Á. G. Horváth [20])
Let P be a parallelotope, $\boldsymbol{z}$ a direction and H a hyperplane transversal to $\boldsymbol{z}$. Then the following statements are equivalent:
(i) the polytope $P+S(\boldsymbol{z})$ is a parallelotope
(ii) the projection of P along the line of $\boldsymbol{z}$ onto the hyperplane H is a parallelotope with respect to the projection of the Venkov lattice $L_{\boldsymbol{z}}$.

We remark that it follows from the propety (ii) that the Venkov-lattice $L_{\boldsymbol{z}}$ of the direction $\boldsymbol{z}$ is an $(n-1)$-dimensional lattice. Next the layers of the lattice L^n are defined:

Definition 5.
The intersection of the subspace generated by $(n-1)$ linearly independent lattice vectors and the lattice L^n is called a layer of the lattice L^n and is denoted by $L^{n-1}_{(0)}$. A vector which supplements a basis of the layer $L^{n-1}_{(0)}$ to a basis of the lattice L^n is denoted by $\boldsymbol{a}_n$. The translation of the layer $L^{n-1}_{(0)}$ with the j-fold of the vector $\boldsymbol{a}_n$ is denoted by $L^{n-1}_{(j)}$.
A few layers of the lattice L^n have the following special property.

Definition 6.
If the sublattice L^{n-1} of L^n has the following property: $R^n\setminus\cup\{P+\boldsymbol{k}_i\,|\,\boldsymbol{k}_i\in L^{n-1}\}$ has two path connected components, then the set $\cup\{P+\boldsymbol{k}_i\,|\,\boldsymbol{k}_i\in L^{n-1}\}:=[L^{n-1}(P)]$ is called a parallelotope lamina. The lattice L^{n-1} is called a laminar lattice.

Note, however, that as it is shown later on, there are lattices which have no layer with this special property.

Definition 7.
A face of P which is common with another parallelotope P_i of the laminar lattice L^{n-1} is called a connecting face of P if it is a maximal common face with respect to the face-lattice of P.

It is easy to see that the dimension of such a face is either $(n-1)$ or $(n-2)$. If we investigate DV cells instead of parallelotopes, then the relevant vectors are facet vectors, too. So for the DV cells the relevant vectors and generalized relevant vectors are called generalized facet vectors in brief (see: [29]).
Let $P\in L^n$ be a point and $\boldsymbol{z}$ be a direction. Intersect the lattice L^n with a $(n-1)$-dimensional hyperplane H which contains the point P and is perpendicular to $\boldsymbol{z}$. Denote the resulting set of the intersection points $L^n\cap H$ by L^{n-1}, if it is an $(n-1)$-dimensional lattice.

Theorem 6. (A. Végh [29])
The following statements are equivalent for the DV cell $DV^n(P)$ and the vector $\boldsymbol{z}$:
(i) the orthogonal projection of the cell $DV^n(P)$ to the $(n-1)$-dimensional hyperplane H along $\boldsymbol{z}$ is an $(n-1)$-dimensional DV cell $DV^{n-1}(P)$ of the lattice L^{n-1}, where $L^{n-1}=L^n\cap H$.
(ii) the vector $\boldsymbol{z}$ is orthogonal to at least one generalized facet vector of each 2 and 3-belt.
(iii) $R^n\setminus\left[L^{n-1}\left(DV^n(P)\right)\right]$ has two path connected components.

We remark that if the property (ii) does not hold then the orthogonal projection of a DV cell to H can still be a DV cell but it is clear that in this case properties (i) and (iii) do not hold, either. One example is the orthogonal projection of the regular hexagon prism in the direction $\boldsymbol{z}$, where the vector $\boldsymbol{z}$ is a normal vector of the lateral face.

4. Extraction of parallelotopes and DV cells

In this section we investigate the connection between the extraction of parallelotopes and the coordinates of relevant vectors.

Lemma 1. (A. Végh [30])
If a parallelotope P can be extracted in a direction $\boldsymbol{z}$ then there exists a basis $\{\boldsymbol{e}_1,\boldsymbol{e}_2,\cdots,\boldsymbol{e}_n\}$ of the lattice in which $[L_{\boldsymbol{z}}]=[\boldsymbol{e}_1,\boldsymbol{e}_2,\cdots,\boldsymbol{e}_{n-1}]$ holds and

the nth coordinates of the relevant vectors which do not belong to the Venkov-lattice $L_{\boldsymbol{z}}$ are ± 1.

Namely, if a parallelotope P can be extracted in a direction $\boldsymbol{z}$, then the Venkov-lattice is a primitive $(n-1)$-dimensional sublattice of L^n and all other relevant vectors have ± 1 nth coordinates in case of a suitable vector $\boldsymbol{e}_n$ completing to a basis.

Lemma 2. (A. Végh [30])
If there is a basis in which the coordinates of relevant vectors of a parallelotope P are ± 1 and the parallelotope P is an affine image of a DV cell, then there exists a direction $\boldsymbol{z}$ such that $P + S(\boldsymbol{z})$ is a parallelotope, too.

Remark that by theorem 5 and in case the above conditions, the projection of a parallelotope P in the direction $\boldsymbol{z}$ is a parallelotope of the Venkov-lattice $L_{\boldsymbol{z}}$. On investigating DV cells instead of parallelotopes it can be seen that the projection is a DV cell, i.e. the following lemma holds.

Lemma 3. (A. Végh [30])
If there exists a basis in which the relevant vectors of the DV cell D have coordinates ± 1, then there exists a direction $\boldsymbol{z}$ such that the projection of the cell D in the direction $\boldsymbol{z}$ is the DV cell of the lattice $L_{\boldsymbol{z}}$.

5. Minimal vectors

Let $A = \{\boldsymbol{a}_1, \boldsymbol{a}_2, \cdots, \boldsymbol{a}_n\} = \{\boldsymbol{a}_i\}$ be a basis of L^n. The minimum $m(L^n)$ of the lattice L^n is defined by

$$m(L^n) \in R^+ : m(L^n) = |\boldsymbol{m}| \leq |\boldsymbol{v}| \text{ for an } \boldsymbol{m} \in L^n \backslash \{0\} \coloneqq \dot{L}^n \text{ and for any } \boldsymbol{v} \in \dot{L}^n$$

We may assume (by a similarity of E^n) that $m(L^n) = 1$. The set of minimum vectors is called the minima of L^n and is denoted by

$$M(L^n) \coloneqq \{\boldsymbol{m} \in L^n : |\boldsymbol{m}| = m(L^n) = 1\}$$

The maximal A-coordinate of the minima of L^n is defined by

$$\mathrm{L}(A) \coloneqq \max\left\{x_i \in Z : \sum_{i=1}^{n} x_i \boldsymbol{a}_i = \boldsymbol{m}, \boldsymbol{m} \in M(L^n)\right\} \in N$$

Consider the minimum of these maximal A-coordinates of the minima of L^n by changing basis A in L^n, i.e. define

$$\mathrm{L}(L) \coloneqq \min\{\mathrm{L}(A) \in N : A \text{ is any basis of } L^n\}$$

Finally, vary the lattices L^n in E^n. Then

$$\mathrm{L}_n \coloneqq \mathrm{L}(E^n) \coloneqq \max\{\mathrm{L}(L^n) \in N : L^n \text{ is any lattice of } E^n\}$$

In general the problem is to give L_n. In other words in any lattice of E^n find a basis, in which the maximal coordinate of the minima of the lattice is the possible smallest.
L_n is determined for $n \leq 5$ in [18], where the unique existence and the increasing of L_n by n are also discussed.

Theorem 7. (Á. G. Horváth [18])
$\mathrm{L}_n = 1$ *for* $n \leq 5$.

By investigating admissible extensions of lattices and classifying the lattices according to their indices we prove in [27] that L_6 is equal to one, i.e. for every Euclidean 6-lattice L^6 there is a basis in which the maximal coordinate of all the minimum vectors of L^6 is equal to at most 1.

Theorem 8. (A. Végh [27])
$\mathrm{L}_6 = 1$.

Á. G. Horváth conjectured that $\mathrm{L}_8 = 2$, he has proved $\mathrm{L}_8 > 1$ by the famous lattice E_8 in E^8 and he has proved the following theorem for root-lattices:

Theorem 9. (Á. G. Horváth [17])
$\mathrm{L}(Z_n) = \mathrm{L}(A_n) = \mathrm{L}(D_n) = \mathrm{L}(E_6) = \mathrm{L}(E_7) = 1$ *and* $\mathrm{L}(E_8) = 2$.

I proved that the coordinates of minimal vectors of the lattice L^7 are smaller than 2 in every case, thus following theorem holds:

Theorem 10. (A. Végh [28])
L_7 is equal to one, i.e. to every Euclidean 7-lattice L^7 there is a basis in which the maximal coordinate of all the minimum vectors of L^7 is equal to 1, at most.

6. Free and nonfree DV cells of root-lattices

We investigate the DV cells of root-lattices and we use the following theorems.

Theorem 11. (J. H. Conway, N. J. A. Sloane [3])
For any root-lattice L^n the DV cell around the origin is the union of the images of the fundamental simplex under a finite reflection group or a Weyl group $W(L^n)$.

The facets of the DV cell are the images of the facets not belonging to the origin of the fundamental simplex under a Weyl group $W(L^n)$. Thus the following theorem holds.

Theorem 12. (J.H.Conway, N.J.A.Sloane [3])
The relevant vectors of a DV cell in a root-lattice are precisely the minimal vectors.

So we proved the following theorem.

Theorem 13.
For the DV cell D (and for its any affine image P) of any root-lattice except the lattice E_8, there exists a direction $\boldsymbol{z}$ such that $D + S(\boldsymbol{z})$ $(P + S(\boldsymbol{z}'))$ is a parallelotope, i.e. the DV cells of any root-lattice are free except the DV cell of the lattice E_8, it is nonfree.

We remark that the importance of the theorem lies in fact that for the DV cell of the lattice E_8 there is no direction for which it can be extracted.

Proof. By theorem 9 for the root-lattices Z_n, A_n, D_n, E_6, E_7 there exists a basis in which the coordinates of minimal vectors of these lattices are $0, \pm 1$. By theorem 12 for the root-lattices the relevant vectors of a DV cell are precisely the minimal vectors. Therefore, by lemma 2 for the DV cell D, resp. its any affine images P of any above root-lattices there exists a direction $\boldsymbol{z}$ such that $D + S(\boldsymbol{z})$ $(P + S(\boldsymbol{z}'))$ is a parallelotope.

In the following we prove that the DV cell of the lattice E_8 cannot be extracted, namely there is no direction $\boldsymbol{z}$ for which $DV(E_8) + S(\boldsymbol{z})$ is a parallelotope. In fact, by theorem 9 there is no basis of the lattice E_8 in which the coordinates of every minimal vector are $0, \pm 1$. So, using theorem 12, there is a relevant vector $\boldsymbol{x}$ in every basis of the lattice E_8, where the coordinate $x_i \neq 0, \pm 1$ for any $i = 1, \ldots, 8$. Suppose that the DV cell $DV(E_8)$ can be extracted in a direction $\boldsymbol{z}$. Then the Venkov lattice $L_{\boldsymbol{z}}$ of the direction $\boldsymbol{z}$ is an $(n-1)$-dimensional. Choose a basis for which $[L_{\boldsymbol{z}}] = [\boldsymbol{e}_1, \boldsymbol{e}_2, \cdots, \boldsymbol{e}_7]$. So by lemma 1 the absolute value of the 8th coordinates of every relevant vector cannot be more than one. Consequently, $\boldsymbol{x} \in L_{\boldsymbol{z}}$ for the relevant vector $\boldsymbol{x}$, where the coordinate $x_i \neq 0, \pm 1$ for any $i = 1, \ldots, 8$. The relevant vectors of the DV cell $DV(E_8)$ in $L_{\boldsymbol{z}}$ are the minimal vectors in the 7-dimensional Venkov lattice $L_{\boldsymbol{z}}$ too, because the Venkov lattice $L_{\boldsymbol{z}}$ is a sublattice of E_8, so the minimum cannot decrease. By theorem 10, in every 7-dimensional lattice you can select a basis for which the coordinates of the minimal vectors, i.e. coordinates of the relevant vectors in $L_{\boldsymbol{z}}$ are $0, \pm 1$. This is a contradiction. So there is no direction $\boldsymbol{z}$ for which $DV(E_8) + S(\boldsymbol{z})$ is a parallelotope, i.e. DV cell $DV(E_8)$ is nonfree.

A similar theorem can be easily verified for the projection of the DV cells of any root-lattices:

Theorem 14.
For the DV cell D of any root-lattice except the lattice E_8 there exists a direction $\boldsymbol{z}$ such that the projection of the DV cell D in the direction $\boldsymbol{z}$ is a DV cell of the lattice $L_{\boldsymbol{z}}$.

Proof. Similarly to the above theorem, by theorem 9 there is a basis of the root-lattices Z_n, A_n, D_n, E_6, E_7 in which the coordinates of the minimal vectors of these lattices are $0, \pm 1$. As by theorem 12 the relevant vectors of DV cells of root-lattices are precisely the minimal vectors, using lemma 3 for the DV cells of the above root-lattices there is a direction $\boldsymbol{z}$ for which the projection of the DV cell D in the direction $\boldsymbol{z}$ is the DV cell of the Venkov-lattice $L_{\boldsymbol{z}}$.

As by theorem 13 there is no such a direction $\boldsymbol{z}$ of the DV cell $DV(E_8)$ for which it can be extracted, by theorem 4, there is no direction $\boldsymbol{z}$ which is perpendicular to at least one facet vector of every 3-belt of the DV cell. So the condition (ii) of theorem 6 does not hold. Consequently, there is no direction $\boldsymbol{z}$ of the DV cell $DV(E_8)$ for which the projection of the DV cell is the DV cell of the lattice $L_{\boldsymbol{z}}$.

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EDUCATION

TEACHING AND LEARNING MUSIC WITH THE AID OF DIGITAL TECHNOLOGY

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Abstract
Hungary is well-known about the Kodály concept which attracts the music educators to Kecskemét, from all over the world. The method has long tradition however it should be renewed to adopt the challenges of the 21st century. Modern ICT could append new ways of teaching music that could be more interesting and enjoyable for student.

Keywords:
Kodály concept, digital pedagogy, ICT, music education

1. Introduction

From research studies it is being proved, that the use of ICT tools in schools can be useful and could motivate the younger generations and ICT contributes positively to music education in several areas, as well [3].

Although ear training programs or other types of musical softwer are often used abroad (EarMaster Pro, GnuSolfege etc.), in Hungary music teachers rarely use any kind of ICT tool during their music or solfege lessons. The problem perhaps is that there are no proper digital didactic materials and tests developed in education [2].

In Hungary music education on every level is based on the well-known Kodály Concept, according to witch musical training should be an integral part of the general curriculum. Musical literacy – it was Kodály's belief, the ability to read and write music is just as important as general literacy [5]. Our aim is to improve students' musical skills with the help of the latest digital technology.

2. Digital literacy

The term digital literacy was initiated by Paul Gilster in 1997 [6]. Marc Prensky (2001) invented and popularized two other terms digital native and digital immigrant in an article in On the Horizon. Digital native focuses on people who grew up with the technology that became prevalent in the latter part of the 20th century and continues to evolve today. A digital immigrant is an individual who was born before the existence of digital technology and adopted it to some extent later in life [7]. According to Ian Jukes and Anita Dosaj many differences exist between the two groups.

Digital Native Learners	Digital Immigrant Teachers
Prefer receiving information quickly from multiple multimedia sources.	Prefer slow and controlled release of information from limited sources.
Prefer parallel processing and multitasking.	Prefer singular processing and single or limited tasking.
Prefer processing pictures, sounds and video before text,	Prefer to provide text before pictures, sounds and video.
Prefer random access to hyperlinked multimedia information.	Prefer to provide information linearly, logically and sequentially.
Prefer to interact/network simultaneously with others.	Prefer students to work independently rather than network and interact.
Prefer to learn "just-in-time".	Prefer to teach "just-in-case" (it's on the exam).
Prefer instant gratification and instant rewards.	Prefer deferred gratification and deferred rewards.
Prefer learning that is relevant, instantly useful and fun.	Prefer to teach to the curriculum guide and standardized tests.

Figure 1. Differences between digital native Learners and Digital Immigrant Teachers, Jukes & Dosaj (2003) [6]

Our students are faced with learning multiple new literacies to succeed in our fast-paced, information-rich world, yet most schools have not caught up with the digital reality that students live in daily. Researchers are needed in Hungary and abroad to explore the facilities in music school, conservatories in connection with ICT.

3. Research in conservatory

The aim of one our former study (2012) was to investigate the musical and ICT skills in conservatory education. Our sample consists of 65 students; 21 boys and 44 girls filled the online questionnaire between the ages of 14 to 19.

According our research in music education it is music literature lesson that ICT tools are used frequently (73%), in music theory lesson it used

rarely (18%). ICT tools are used during solfege lessons very rarely; this is very strange because in the asked conservatory in every room there are interactive whiteboards and projectors. According to the results 85% of students never use ICT tools during solfege lessons, although they would like to (75%).

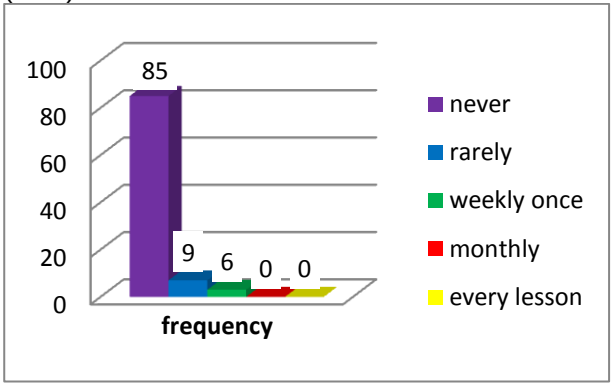

Figure 2. Using ICT during solfege lessons (Buzas 2014) [1]

4. ICT tools in music education

In our paper we would like to introduce some popular musical software that could help fostering students' development during music lessons. The eartrainig and sight-singing software; EarMaster is designed for music students and music lovers who would like to develop their musical skills extensively through a series of practical and theoretical music tasks. The software has more than 2000 sight-singing, ear training and rhythmic exercises for all levels and also a general course for all musical styles and jazz course with swing rhythms and jazz chords.

To help assessing for the teachers it contains a detailed statistics to monitor students' progress. The students can answer questions with multiple-choice buttons, the notation staff, on-screen instruments (piano, guitar, bass, violin, cello, mandolin, banjo, etc.), solfege syllables, scale degrees and more. Students can use a microphone to sing, clap or play their answers in real-time. Over a hundred instrument sounds are sampled from real instruments. The latest version of the program is now available in Hungarian language, too.

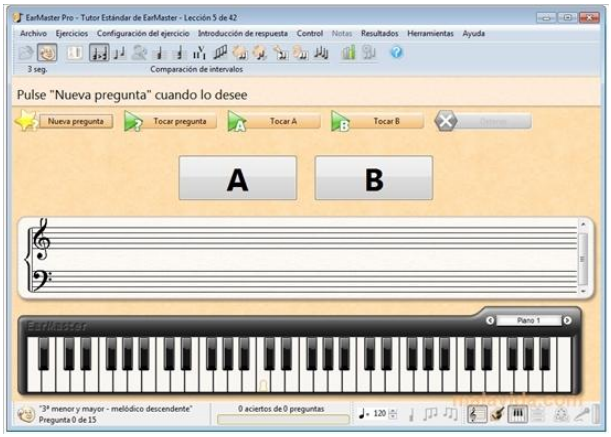

Figure 3. EarMaster 6 software GUI.

Sibelius is one the world's best-selling and most popular music notation software, used daily by composers, music teachers and students alike. With Sibelius students can express, accelerate and promote their musical creativity. Sibelius provides the fastest, smartest, easiest way to write music for live performance, film and television, media entertainment, or in the music classroom.

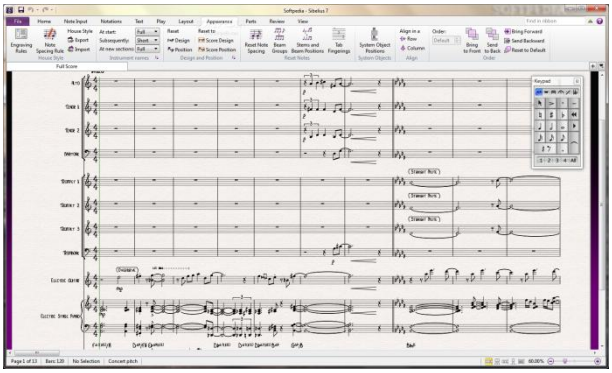

Figure 4. Sibelius 7 software GUI.

One of the latest musical software is called Jordantron. This is the first time, that Jordan Rudess, who is best known as the keyboardist for Dream Theater, has released a complete set of his exclusive sounds to the public. Jordantron will turn music students' iPad into an easily handled sounding instrument, the app consists of two keyboards with many useful musical aids.

Figure 5. Jordantron software GUI.

The online program, Musical Mysteries is designed to help to support elementary school students between the ages of 7-11 year olds. The resource helps pupils to explore basic musical concepts in sound, rhythm and mood. As the pupils work their way through the site, they gain valuable listening, composing and musical interpretation skills.

Figure 6. Musical Mysteries on-line software GUI.

5. Eye-tracking analysis

Eye-tracking analysis has become nowadays a popular tool in methodological researches. Eye movement in music reading – the scanning of a musical score by a musician's eyes – is a very complex phenomenon. Eye-movement studies usually focus on instrumentalist students – pianists, violin or guitar players, less studies deal with singers and only a few of them are about a specific music teaching method. Most researches with eye movement in music-reading have primarily aimed to compare the eye movement patterns of skilled and unskilled performers, who typically sight read the same passage at different tempos and/or levels of accuracy. Researchers suggest that the individual's musical skills significantly influence the eye movements during music reading. In Hungary Dr. János Steklács is the most well-known researcher in eye-tracking, students from Kecskemét College have the opportunity to initiate researches in the field of music education, as well.

Figure 7. TOBII eye-tracking software GUI.

6. Further aims

The aim of our further research is to create an online assessment system for testing the musical abilities in conservatory students. A new electronic assessment system has been developed recently at the Center for Research on Learning and Instruction, University of Szeged. The new platform is called eDIA (e-Assessment Diagnostic Platform), that can contribute significantly to the development of our education system. The eDIA system can provide a quick feedback about student's knowledge and ability levels.

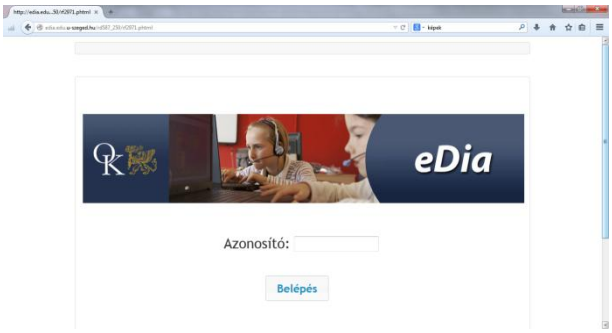

Figure 8. eDIA assessment software GUI.

The assessment would be computerized adaptive testing that adapts to the students' ability level. The musical items are mainly based on the Kodály Conception. In our research we also use Seashore's Model of Musical Abilities, Erősné's Model of Basic Musical Skills and D. J. Elliott (1989) dynamic model of multicultural music education. According to Elliott, a teacher's task is to strengthen the students' specific musical individuality, and with the students together is to explore the cultural background of the compositions.

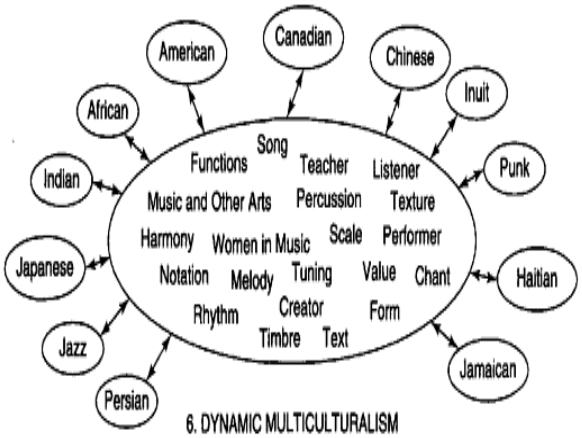

Figure 9. Elliott's 6th model of dynamic multiculturalism of music education.

We would like to compare the results of the different age groups and also examine the connections among the development of mathematical, reading and writing skills and musical abilities.

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THE EFFECT OF SELECTED MOTOR ABILITIES ON THE RESULTS IN THE ATHLETIC DISCIPLINE – RUNNING LONG JUMP

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Abstract
Methodological approach of this paper is focused on creating selection procedures in athletics. The ultimate goal of the selection and the orientation is to select and guide, in order for the level of motor abilities to be used to its optimum and to raise that level using a programmed training process, all with the goal of developing and reaching maximum results in this sports activity, the running long jump. The aim of this research was to determine which of the selected motor abilities effect the result in the running long jump with junior girl athletes, to the fullest extent. The examinee sample consisted of 31 young girl athletes, attendants of the athletic school, all of whom joined the athletic school six months prior to testing. Variables sample constituted a criterion variable running long jump and eight motor tests as predicators. Given results (R=0,88 and R2=0,77) indicate that there is a strong connection between predicator variables and success criterion in the discipline running long jump with the young girl athletes, which is significant with the error of p=0,00. Based on the analysis of the effect of particular predicator variables, it can be seen that the only significant effect on the criterion variable stems only from the predicator running long jump (b=0,74; p=0,00). On the basis of these given results, it can be concluded that in order to be successful in the running long jump with young girl athletes, the factor of explosive power jumping ability is the only relevant factor that effects the results prognosis.*

Keywords:
selection, jump, motor abilities, take-off

1. Introduction

Athletics is one of the oldest forms of sports competitions in many nations since the times of ancient Greece. The tradition of those types of competitions is as old as sport itself so we can say that history of athletics is actually the history of sport in general. Athletics is one the most basic and wide spread sports sectors. As a sport, it contains a wide range of natural forms of movement and it's a well known fact that success in most sports today is achieved by proper running form, jumps, walking, throwing, etc [1].

The development of athletics is based on the application of scientific research on different levels of complex planning, programming and training control with athletes of different age and quality categories. There are a large number of selection models and methods in athletic sports, however there isn't a unified model of initial athletic selection and orientation [2].

From a long jump technique stand point, there are four phases:

Approach – achieving a horizontal speed that needs to have its maximum value in the moment of take-off

Take-off – active placement of the take-off foot on the board. A short amortization phase. Fast and energetic take-off, with full extension of the ankle, knee and hip joint.

Flight – keeping a stable balance, appropriate coordination of arms and legs and setting the landing conditions

Landing – the jumper's body being in such a position in the moment of contacting the ground, which will ensure making the longest jump possible.

Explosive power is also an important factor and the basis for achieving good results in activities such as jumps in jumping events in athletics, in which accelerating body mass and the mass of certain body parts is essential. In jumping events, in order to achieve noted results, aside from motor abilities and explosive power which is the basis for everything, an athlete also needs speed, stamina and coordination [4 and 5].

The effect of selected motor abilities on results in the athletic discipline of running long jump with young girl athletes will be analysed in this paper. How big that effect is and how big is the effect of particular predicator variables on the criterion variable of standing long jump will also be reviewed.

Methodological approach of this paper is aimed towards creating selection procedures in athletics. Selection and orientation in athletic disciplines is a long-term process that begins at the age of 6 to 10

years old and lasts continually up to junior level, in which some changes are still possible. Only a timely and quality selection and orientation brings top results [4 and 5].

The issue with of paper is manifested in the fact that a restrictive component and a limiting factor for development and progress in athletics are morphological features that aren't included in this paper. A large number of scientific researches deal exactly with this effect of morphological features on results in athletics. In each one of these researches, a significant influence of body type and build on accomplishments in athletics is determined. A preliminary selection and orientation is extremely important as a success factor in a particular competitive activity. The ultimate goal of selection and orientation, form this paper title's point of view, is to select and guide in order for the motor abilities to be used to its optimum, to raise the level of those abilities with the goal of development and growth using a programmed training process, and achieving maximum results in the sports activity of the running long jump.

The goal of this research was to determine which of the selected motor abilities effect the results in the running long jump with young girl athletes, to its full extent. In accordance with the present findings and a defined basic goal of this research, the following hypothesis was formed:

H1: there is a significant effect of selected motor abilities on the results in the athletic discipline of running long jump.

2. Method

Examinee sample: 31 young girl athletes, 8th grade students, attendants of the athletic school in Split. All of the examinees joined the athletic school six months prior to testing. The training program of these attendants was based on an all-round development of basic motor abilities and on adopting techniques from various athletic disciplines.

Variable sample: criterion variable of the running long jump and eight motor tests as predicators:

MRSPTL – backwards training ground;
MKUS – side steps;
MTAR – hand tapping;
MTAN – foot tapping;
MSDM – standing long jump;
M20V – high start position 20m run;
MDTS – bent legs crunches;
MVIS – a high pull up hold.

Methods of data processing: they include calculating descriptive statistic parameters: arithmetic mean (AS), standard deviation (SD), minimum (Min) and maximum (Max) result, asymmetry measures (Skew) and curvature distribution (Kurt).

Normality distribution testing was conducted using a KS test and each variable showed that there isn't a significant distinction between the results distribution and the theoretically normal results distribution.

In order to determine if there is a significant effect of selected motor abilities on the results in the running long jump, a regression analyses was used. The data was processed using a statistic program STATISTICA 11.0.

3. Results and discussion

The basic statistic parameters have been calculated using descriptive statistics and results can be seen in Table 1. Having previous knowledge of motor tasks that represent predicator variables, already from the minimum and maximum results parameters, we can notice that that there is a great discrepancy between girl athletes. Most of standard deviations indicate that a great span between minimum and maximum result values wasn't given by values of a single extreme examinee, but by a high dispersion of results of all athletes in all predicator variables. The asymmetry measure shows values close to zero in all predicator variables, which tells us that the dispersion of results with athletes is simetrically distributed. Curvature measures also have close to zero values (with a little larger dispersion than with asymmetry parameters), but in any case significantly below a4=3, which is another confirmation about a great dispersion of results with athletes in all predicator variables.

Table 1. Descriptive indicators of measuring variables.

	AS	Min	Max	SD	Skew	Kurt
MPOL	10,85	6,80	15,20	2,25	0,59	-0,47
MKUS	9,87	8,00	12,40	0,97	0,66	0,58
MTAR	36,81	31,00	43,00	2,99	0,57	-0,06
MTAN	21,29	16,00	25,00	2,18	-0,65	0,64
MSDM	196,71	140,00	241,00	27,44	-0,05	-0,95
M20V	3,36	3,00	4,00	0,26	0,75	0,50
MDTS	23,97	18,00	35,00	3,69	0,88	1,36
MVIS	22,19	5,20	40,00	9,40	0,39	-0,76
MSDZ	379,71	310,00	472,00	43,87	0,51	-0,68

***AS**-arithmetic mean, **SD**-standard deviation, **Min**-Minimum value, **Max**-maximum value, **Skew**-asymmetry degree, **Kurt**-curvature degree*

As we can see from Table 2. the value of multiple correlation coefficient is big (R=0,88) as is the coefficient of multiple determination (R2=0,77), which tells us of a great correlation between predicator variables to the criterion significant with an error of p=0,00, according to a F-test.

Table 2. Regression analyses.

R = 0,8787
R^2 = 0,7722
F (8,22) = 9,3239
p < 0,00002

***R**–multiple correlation coefficient, **R2**–detrermination coefficient, **F**–the F-test result, **p**–significance level*

Nonetheless, in Table 3. we can see that the only greater influence on the criterion variable comes from the predicator MSDM (b*=0,74, p=0,00), while the regression coefficient of other predicator variables is considerably lower and not statistically important. From the afore mentioned we can conclude that out of all the measured motor tests, only the standing long jump possesses a relevant effect on the result prognosis in the running long jump.

Table 3. Regression coefficients of predicator variables

	b*	b	t	p
MPOL	0,183	3,578	0,780	0,443
MKUS	-0,271	-12,229	-1,275	0,216
MTAR	0,119	1,747	0,935	0,360
MTAN	0,114	2,295	0,615	0,545
MSDM	0,736	1,177	4,058	0,001
M20V	0,178	29,896	1,102	0,282
MDTS	0,122	1,453	0,964	0,346
MVIS	-0,022	-0,104	-0,171	0,866

***b**–beta coefficient, **b**–partial regression coefficient, **t**–the t-test value, **p**–significance level*

The take-off in the running long jump requires control of the musculature activation, the duration of a certain type of activation and the decrease of the duration of the contact to the ground. The improvement of pre-activation and muscle relaxation in fast eccentric-concentric movements is of extreme importance. That especially requires a better muscle activity control, increase in the muscle tendons system tension of the take-off foot in the take-off phase, and the more efficient transfer from the eccentric concentric contraction. The optimal pre-activation of the included musculature/agonist and the antagonist/before the take-off ensures the stiffness of the ankle and the knee joint, which results in a smaller amplitude and shortening the eccentric phase duration. The mentioned muscle contraction characteristics ensure a more efficient take-off action. This is especially evident with women jumpers where we can notice a difference according to the success rate of performing the take-off in extreme conditions of greater speed and force that are applied on the locomotor system. The reason for which the predicator variable of a 20m run didn't display a more significant effect on the success in the long jump, may be explained by an insufficiently strong musculature of the extension of the take-off foot in the amortisation phase and the extension during the take-off.

To me, as an author of this paper, form the bundle of predicator variables and at least for the population of young girl athletes, a motor ability that would have an at least reduced, but still a significant influence, was expected to be noticed. It can be concluded that the take-off is the only relevant factor that affects the results in the running long jump with young girl athletes, to its full extent, according to this paper.

4. Conclusion

This research had the goal of determining which motor abilities effect the results in the running long jump with young girl athletes, to its full extent.

The basic statistic parameters (minimum and maximum results, standard deviation value, asymmetry measure and curvature measure) point to a high results dispersion of all athletes in all predicator variables.

The given results indicate a strong connection between predicator variables and success criterion in the running long jump, which is significant. Based on the analyses of the influence of particular predicator variables, the only significant effect on the criterion variable comes from the predicator of standing long jump, while the regression coefficients of other predicator variables are considerably lower and therefore not significant.

Based on these given results it can be said that the only relevant effect on the prognosis of results, important for the success in the running long jump, is the explosive jumping power factor.

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ICT TOOL FOR EDUCATION OF EUROPEAN CITIZENSHIP
EDUCATIONAL PROGRAM FOR SPREADING THE CULTURE OF THE EUROPEAN UNION MEMBER COUNTRIES

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Abstract
Hungary has joined the European Union 10 years before. However the younger generations don't even know basic information about the countries, just like the anthems, flags, capitals, maps etc…the goal of our software to teach as much as possible of these information to the elementary school-aged generation – in a modern way, using the tools of multimedia and digital pedagogy.

Keywords:
European Union, anthem, software, digital pedagogy, elementary school, map, ICT

1. Introduction

The gap among the European Union member countries is obvious. The reasons are based on multiply factors, and one of these is the not acceptable knowledge of each other. Including the cultures of the other countries, unfortunately the young generations of European Union do not know "each other". The "European Youth Dialogue 2014" (8-11 May 2014 in Thessaloniki, Greece) has in it political manifestation: "Youth is "systemically" relevant, their hopes and needs concern everybody in Europe!" The members agreed "without the consent and the enthusiasm of the youth, the European project will fail. Yet, the European youth will not allow themselves to fail, nor wants to be a victim. The youth will take the future in its own hands, intervening with actions and connecting to networks" expressed the Director of Heinrich-Böll-Foundation Greece (Olga Drossou), at her introductory speech. The goal of this meeting was to get to know each other, exchange ideas and get motivated to strengthen their self-determination and participation [1]. Based on – including the "European Youth Dialogue 2014" ideas - the Council Regulation (EU) No 390/2014 of 14 April 2014 establishing the 'Europe for Citizens' program for the period 2014-2020 [2].

The aim of this program:

- To contribute to citizens' understanding of the EU, its history and diversity.
- To foster European citizenship and to improve conditions for civic and democratic participation at EU level.
- To raise awareness of remembrance, common history and values.
- To encourage democratic participation of citizens at EU level, by developing citizens' understanding of the EU policy making-process and, by promoting opportunities for societal and intercultural engagement and volunteering at EU level [3].

Connecting to this idea-chain we have decided to create an ICT tool for young elementary school pupils to learn more about the European Union.

2. About the software

We planned the software to use primarily in Hungarian schools and homes, based on this our decision was developing for Windows platform. However not everyone uses Windows, so we decided to use the default media playing application form the actually used operating system (e.g MacOS-X, Linux…). The software is a native Win32 application, therefore it does not need any runtime environment (.NET, Java), so it can run on a Windows XP (or above), or any Windows emulator (e.g. Wino on Linux). The software is freeware, it can be distributed freely under the GNU General Public License.

3. How the education module works in software

We have tried to simplify the graphical user interface (GUI) as much as possible. The users of this program will be under 10-year-old children, therefore the menu structure cannot be complex. As you can see (Figure 1.), the frame program is simple.

Figure 1. Opening screen

By today only (31-Aug-2014) the Hungarian version is developped, however we are currently working on the English version.
The opening screen welcomes the user, and he/she can start decide from the cascading menus. These menus are (in order of appearance):

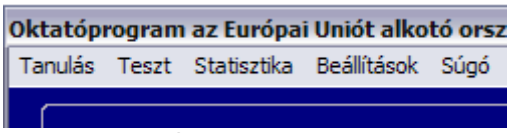

Figure 2. Menus

"Tanulás" (Learning) where pupils can learn the materials about some EU topics.

These topics are:

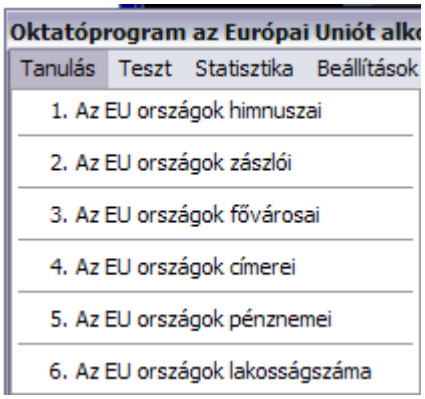

Figure 3. Submenus of "Learning"

- Anthems,
- flags,
- capitals,
- escutcheons,
- currencies,
- number of population

of the European Union countries.

If the user clicks on the first item ("Anthems of the European Union countries"), the next page appears:

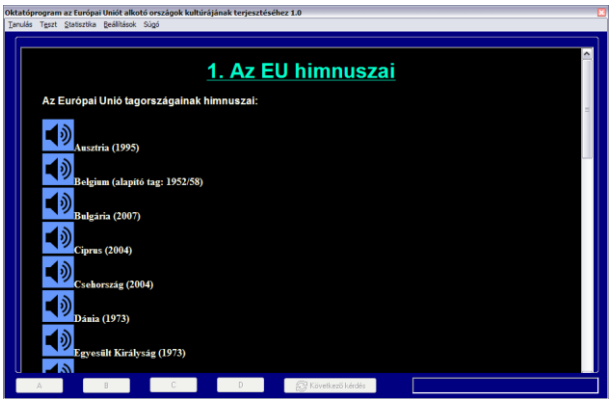

Figure 4. Anthems screen from Learning module

On this page the user can decide which country's anthem should be played, then clicks on the "blue loudspeaker" icon in front of the name of the county. This user even starts the default media player of his operating system, and plays the mp3 sound file.

4. How the test module works in software

After finishing the learning process, there is possibility for immediate knowledge assessment – using "Teszt" (Test) module.

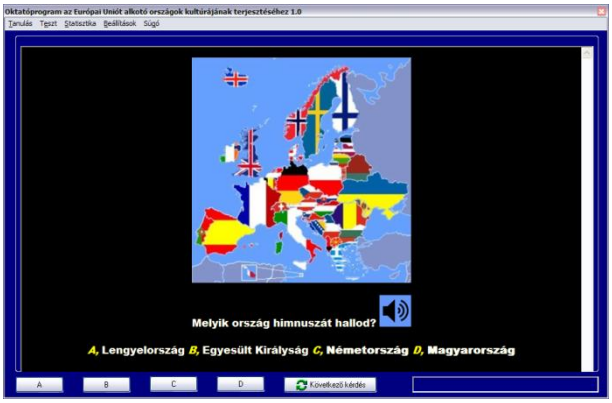

Figure 5. Anthems screen from Test module.

The visible question is "Which country's anthem you can hear now?".
There are 4 possible answer respectively marked "A", "B", "C", "D", and all letters followed by a country name. The user has to choose the right country after listening to the anthem. By clicking on the "blue loudspeaker" icon, the anthem can be listened – as described above.

The software immediately responses the answer is correct or not.

If the answer is correct:

Figure 6. Immediate assessment 1

"Your answer is good" message displayed, else

Figure 7. Immediate assessment 2

"Your answer is bad; the "B" should have been good". Obviously the letter of the right answer dynamically changes.
These working method models all the other modules.

5. How the statistic module works in software

Like any ITC educational software, it needs to have an altogether statistic module about the whole assessment process.

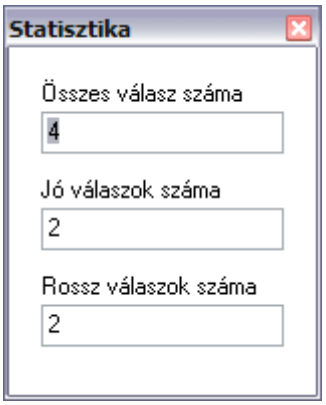

Figure 8. Statistic of the assessment process

Hereby the user can see:

- Összes válasz száma = number of all answers
- Jó válaszok száma = number of good answers
- Rossz válaszok száma = number of bad answers

are collected by the software during the test process.

6. How the settings module works in software

The settings of the program does not need any programming skill, or even advanced computing knowledge. The "Beállítások" (Settings) menu contains every necessary setting possibility.

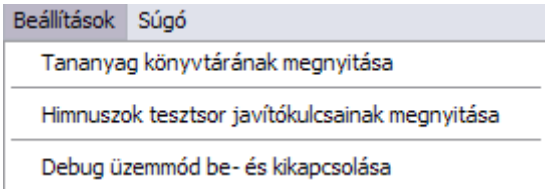

Figure 9. Settings module

Tananyag könyvtárának megnyitása = opening the directory of learning materials – it contains all the written materials in .mht format (can be edited easily, even with Word), and all the multimedia files (pictures, audio, video…)

Himnuszok tesztsor javítókulcsainak megnyitása = opening the answer keys ot the anthem test, where the answer keys can be easily modified or new ones added.

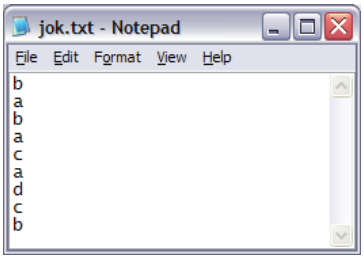

Figure 10. Answer keys

Debug üzemmód be- és kikapcsolása = set the debug mode on and off in the software. This can be useful, if the user and the lecturer are physically far away from each other.

7. Conclusion

This software, like other ICT educational software can be used as a part of digital pedagogy in classes, or a tool of distance learning [4] – and even a simple computer game for young children. It has already been proven, that computer game-like ICT softwares are more popular among students [5], and these softwares can be used to develop cooperation and digital competencies [6] therefore more and more ICT softwares are used even in classes for teamwork, not just in stand-alone work [7].
We plan to get the statistical results of the students using an on-line survey, and hopefully we will have a database about the Hungarian young generation's knowledge of the European Union.
Our other goal is to continue the development of the program, if the responses will be positive from the users during the pilot study.

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IS IT LEGAL OR ILLEGAL TO USE TORRENTS? VIEWS OF LIBRARY SCIENCE STUDENTS ABOUT FILE SHARING

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Abstract
The fast development of infocommunication has given the people a lot of possibilities. One of its important effects is the problem of accessing files on the internet. Our research aim was to explore the future experts' views about this problem. We examined the views of students of Library and Information Science about sharing files and using torrents. Our sample consisted of 76 BA and MA students from the Institute of Library and Information Science of Eötvös Loránd University. We developed a questionnaire to examine how the students use the torrents, what their attitudes are toward the problem of legality. According to our results the students use torrents quite often although they are aware of their illegality. Most of the students would punish using torrents, but the opinions are different about who and how should be punished. Our results show the effect of the education: the MA students' attitudes toward torrents are significantly more negative than BA students.

Keywords:
torrent, peer to peer, file sharing, copyright, ethic

1. Introduction

Downloading and sharing files on the internet is a new problem in the field of media consumption. The legal regulation, which becomes stricter and stricter, and the developing technology have generated the wide publicity, debates and legal proceedings, and the problem of file sharing has become not only legal but social and public policy. The technological innovations enable the users to copy, share, upload and download enormous quantity of data, although it harms certain rights. In the era of paper-based documents the people shared documents without any sense of copyright, but nowadays we are experiencing the users' legal self-awareness. Some decades ago copying documents for private purposes was not a copyright issue, and it hardly caused any harm to authors or publishers. However, today you can make more damages in the public space of the internet.

File sharing means making digital contents available in public or in closed communities, and with its help, if you are entitled, you can download or use the files. File sharing outside the network works the same, namely to pass contents with the help of a datatraveller from one user to another [1]. These systems do not use any central servers for passing data to be shared or to be stored. The users or peers in the network connect to each other directly [2]. Peer-to-peer file sharing is often associated with sharing copyrighted contents illegally [3], [4]. Peer-to-peer file sharing services are often constrained because of their widespread use for sharing copyrighted content illegally, and because of their consumption for mostly non-work-related uses [5].

File sharing became very popular firstly in college campuses. There were a lot of students with low budgets, high interest in music, films, videos, etc. and high speed connections. For a long time universities were out of direct control. In the USA and in some European countries enormous efforts were made to change the culture of file sharing in universities, but the results are mixed [3]. In Hungary the file sharing in the universities are constrained as well, but the students' file sharing behaviour is not widely explored. That is why we regard very important to study the Hungarian university students' file sharing behaviour. Our research is a pilot study, so it is the first step in measuring students' attitudes and behaviour.

2. Methods

Our research aim was to study the students' attitudes toward file sharing and use of torrent sites and to map their file sharing and downloading habits. We examined students of Library Science because we think their file sharing and downloading behaviour should be more conscious than the average students', as they are the future experts of this field. Our other aim was to show the effect of the Copyright seminar on the students' file

sharing behaviour. We expected that the deeper insight in the legal regulation and copyright would form the students' attitudes. We used a questionnaire to measure the students' internet using and file sharing behaviour, the frequency of using torrent sites and the most frequently downloaded contents. The last part of the questionnaire contained items about the ethic of file sharing.

Our research sample consisted of 76 students of Library and Information Science from Eötvös Loránd University. 42 of them were BA and 34 were MA students.

We hypothetized that the perception of file sharing is not definitely negative. We supposed that students often use torrent services, and they do it mostly because of the prices. We expected the MA students to be more law-conscious because of their professional socialization.

3. Results

According to the results the internet plays an important role in the students' life. Majority of the students (66 persons, 86,8%) use the internet at home, 68 (89,4%) students have internet subscription, and all of the students have legal access to the internet, however 2 students use Wi-Fi illegally, as well. On average they use the internet 3,25 a day, and most of the students (49 persons, 64,4%) use their own laptops for that. Tablets and smartphones were not used for internet in the sample except for 2 students.

Illegal file sharing means passing and accepting digital contents downloaded for payment or downloaded illegally. We asked the students about their passing legally accessed paid content to another person for free. 28 persons (36,8%) do pass legally obtained file and 48 persons (63,15%) do not. Interestingly 64 students (84,2%) accept from another person legally downloaded file, moreover 47 students (61,8%) accept illegally downloaded files. 16 persons (21%) usually check the legality of the downloaded file, and 18 persons (23,6%) pay for digital contents. The students seem to break copyright by accepting files rather than obtaining them, perhaps they think the responsibility is less when they „just" accept files.

As to the frequency of using file sharing services, it can be said that only 12 persons (15,8%) use file sharing services on daily level, 52 (68,4%) students use torrent services but less frequently, and 12 persons (15,8%) have never visited torrent sites (Figure 1.)

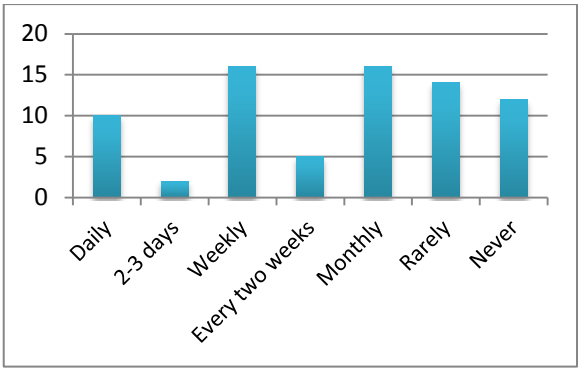

Figure 1. The frequency of using file sharing services per persons

The students use file sharing services mostly at home (57 persons, 75%). This can be explained with the fact that using torrent services are constrained at universities or at workplaces. If we consider the average amount of downloaded data (2GB<), we must say the result is ambiguous, because most of the students download not so often and not so big files, while few student download very often and big files. The students have used file sharing services for three years in average, so it does not seem to be a new way of getting digital contents for students. This is proved by the fact that 65 students (85,5%) know how the torrent services operate. 54 persons (71%) use file sharing services alone without any help, 35 students of them learned to use torrent services by him- or herself, 19 learned with help. 14 persons ask somebody to download a file which he or she needs.

We asked about the contents the students usually share. The students could tick more answers. Films (51 persons, 67,1 %) and TV series (48 students, 63,15 %) were the most popular contents, but students like sharing books (32 persons,42,1 %) and music (26 persons, 34,2 %), too (Figure 2.).

We asked the students to write down the torrents sites they usually visit. Most of the students wrote two sites at least. The most popular sites are the following: Pirate Bay, Ncore, Isohunt, SWshare, Bittorrent. These sites can hardly be associated with professional contents.

The students' attitudes toward illegal file sharing are mixed. 29 students (38, 1%) like using torrent services, 18 of them (23,6%) are regular users, 11 (14,4%) persons use file sharing services less frequently. 28 person (36,8%) use torrent services just in case of high need. 2 persons have never used any of them and condemn people who get digital contents illegally, while 17 (22,3%) persons have never used or used once the file sharing sites, but do not have negative opinion about the users.

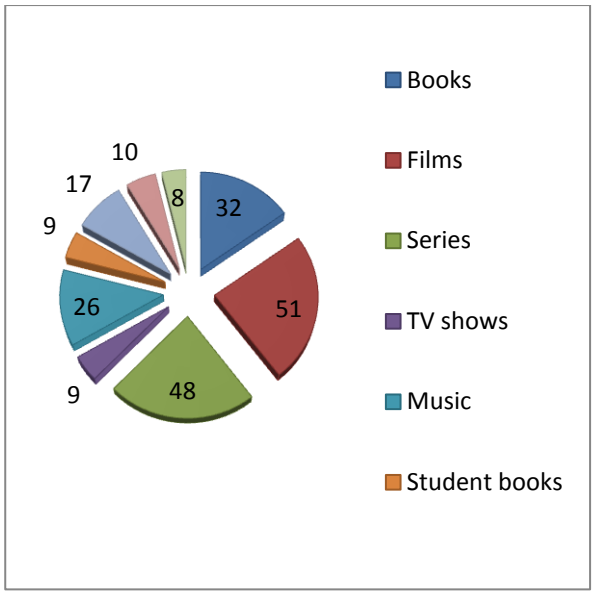

Figure 2. The frequency of downloaded contents per persons

We wanted to know the students' views about the legality of file sharing. 32 respondents (42,1 %) think using torrent services is illegal, and 44 students (57,9%) think it is legal. 37 persons (48,6 %) wouldn't punish illegal file sharing at all. 12 students (15,8 %) would punish the uploaders, 13 persons (17,1 %) the services and 8 persons (10,5 %) the server sites (Figure 3.).

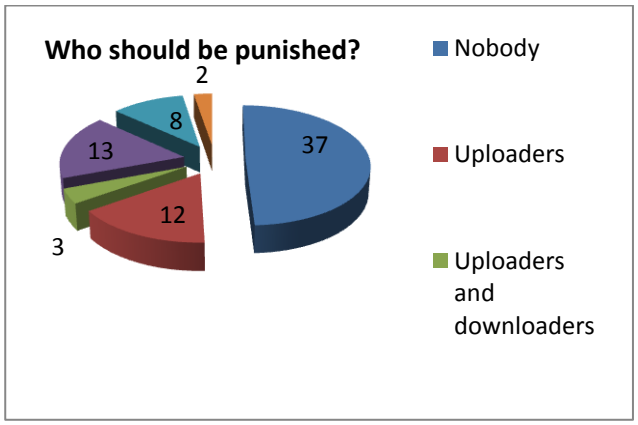

Figure 3. Persons or services the students would punish for illegal file sharing

We asked about the way of punishing. 26 persons (34,2 %) prefer fines, 7 – 7 persons (9,2-9,2 %) think public work or constraining the internet use is the right form of punishment, while 5 persons (6,8 %) would combine the forms of punishment. The respondents were slightly inconsistent in answering the questions about punishment: at the previous question 37 persons ticked the answer for punishing nobody, and when we asked how they would punish them, 6 persons of them changed their minds (Figure 4).

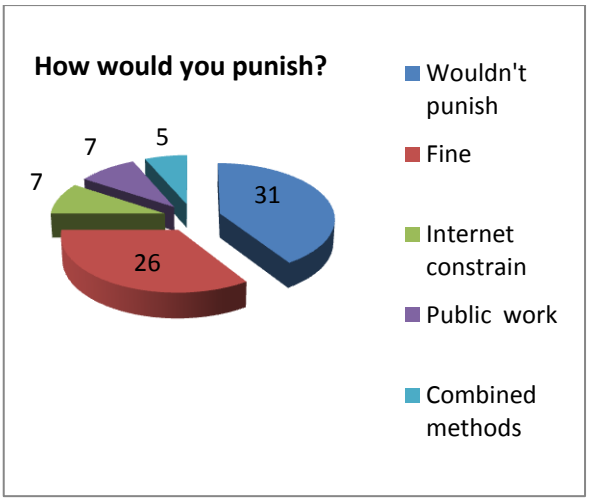

Figure 4. The ways of punishment

We were curious about the students' moral judgement of file sharing in comparison with other illegal or unethical activities. The students should mark on a 1-10 scale how immoral or moral the given activity, where 1 meant the absolute moral and legal activity and 10 represented activities to be punished or crimes. The categories were: animal torture, theft, file sharing, fighting, tax evasion, cheating at school, travelling without validated ticket, stealing Wi-Fi. The students regard animal torture (9,71 average point) and theft (9,02 average point) the biggest crime. Fighting (6,87 average point) and tax evasion (8,22 average point) were also perceived negatively. Travelling without validated ticket (5, 65 average point) stealing Wi-Fi (5,42 average point) and cheating at school (4,95 average point) were not clearly regarded immoral (Figure 5.). Sharing files on torrent sites were perceived the most positively, rather moral than immoral (3,91 average point).

If we look at the causes of popularity of torrent sites among university students, we must consider the financial side of accessing files legally. 51 students (67,1%) think that the legal file sharing depends on the price, i.e. they would pay for digital contents if the access was cheaper. 14 (18,4%) persons would use only the free legal file sharing services besides illegal torrents, and 12 persons (15,7%) would use just the legal file sharing services if the price was lower.

We compared BA students and MA students to show the effect of the added value of the Copyright seminar. We expected the MA students more self-aware in file sharing. According to paired T-test significantly more BA students accept downloaded files. They use torrent sites significantly more frequently, they download higher amount of data

and there are more regular users among them than among MA students. BA students perceive stealing Wi-Fi and using torrents significantly more positively than MA students. However, significantly more MA students check the legality of a file.

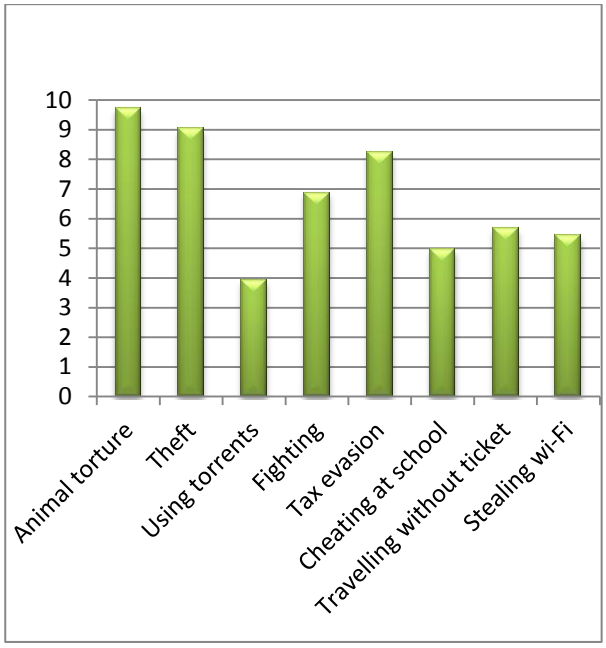

Figure 5. The moral judgement of different activities

4. Discussion

We examined the file sharing behaviour of students of Library and Information Science. We expected a certain level of self-awareness and moral sense due to the professional socialization. Our results partly proved our hypothesis. Most of the students know torrent sites and share files frequently, while few students have never tried any file sharing services. The most popular contents are films and TV series, but books are also popular among student librarians. This result suggests that students download files mainly for entertaining and not for professional purposes. The results also suggest that the students do not really know the legal regulation of using torrents, and more than 50% of them think that it is legal. Most of the students would punish illegal file sharing, but the form of punishment differs in according to their opinions. It is important to emphasize that one of the main reasons for sharing files illegally is the price of accessing legal digital contents. Students have time for entertaining but they have little money for that, so they try to find the cheapest way to spend their free time. Our research showed the added value of education, too. MA students, who have had Copyright seminar, were more aware of the legal problems of file sharing than BA students. Their file sharing behaviour differed from BA students in some aspects.

5. Conclusion

This pilot study showed the importance of developing students' legal sense in relation with file sharing. This new media use behaviour is not perceived clearly, the social norms haven't followed the legal regulations, yet. That is why it is very useful to teach the main issues of copyright and file sharing to students, to build them in their professional socialization. This study has several limitations. People tend to give more positive picture about themselves, when they are asked about their illegal habits, than they are in reality. Other limitation of the study is that we compared BA and Ma students to show the effect of education. The real effect would be gained by measuring the same group of students at several times during their education. So we plan to do a longitudinal study with a larger sample size to show the added value of education.

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ASSESSING COMPETENCIES OF FRESHMEN: AN ON-LINE MEASUREMENT IN THE COLLEGE

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Abstract
The expansion of the higher education and other harmful factors cause that many of the students entering the higher education do not have suitable learning skills and motives. The differences in development of competencies and in self-knowledge of the students make the educator assistance difficult in the acquisition of the additional knowledge and learning skills. The primary aim of our research was to prepare our students' competence map. Based on this we can give a global picture of the cognitive and affective development of our freshmen for the staff. Additionally, we can set the domains to be developed for the students. In order to realize these aims, we developed an on-line test and a questionnaire.

Keywords:
higher education
measurement of competence
online testing

1. Introduction

The higher education institutes, especially the colleges in the country face the problem of dropout. Besides it the success of the training is often measured with the ratio of dropout. [1] That's why one of the main policies of higher education is to improve the efficacy and quality of education so that they could reduce the ratio of dropout, promote students' success in higher education and smooth the transition between higher education and labour market. [2] However, we are experiencing a paradigm shift in measuring efficacy in higher education. The new requirements of knowledge society, the changing concept of knowledge, preparing students for the life-long learning implied the change in measuring efficacy in higher education. [3] The focus has been put on the output, so as what the students will be capable for as they get out into the labour market. [4] Measuring students' competencies can be a suitable methodological tool to check and follow the efficacy of the education. According to CHEERS survey, one of the best indicators of the professional success is competence acquired during higher education. The different higher education institutes improve different specific competences, although the generic competences, which are developed often indirectly in higher education, also play important role in the students' success. [5]

The description and definition of student competences, measuring competences are more and more popular topics in higher educational researches. The leaders of the higher education institutes have begun to take the results of the measures into consideration and the training requirements are often described in competences. [6] The result of measuring competences is a good feedback for the institute about the teachers 'work efficacy and the students skills and competences. Besides it the students can get a feedback about the competences to be developed, and about the competences which are necessary for their future profession. [3] Measuring student competences is informative for the employers as well, because the definition and clarification of the requirements of a profession in competences can smooth the students' transition into the world of work. [6]

The definition of competence differs in the higher education researches. There are holistic, multidimensional and functionalist systems of competences approaches. [7] The researchers make difference between the concept of competence and competency in English. The first one means an integrated ability while the latter means skills which can be identified easily and which contribute to solve the tasks. [8] In Banta's hierarchic system there are three levels of competences. On the lowest level there are the inborn personality traits, the skills are built on them, while on the peak of the pyramid you can find the competence. [9] In this sense competence is the level of integrated experiences.

Despite the difficulties of defining competence, a lot of competence theories and models have been generated all over the world. These theories and models have common characteristics:

1. Their content in general interpretation: what you should know to behave effectively and productively.

2. Their content in factual interpretation: mapping of the competences (their functions, components, organization and operation)

The first competence models were set up in the 1990s in the frame of OECD INES (Indicators of the Educational System) and referred to analyse the competences described in the curriculum. [3] To harmonize the international programs which aim to develop the efficacy of the training in the higher education a common set of competences is needed. There are some attempts to collect the most important generic and specific competences. ESCO is the set of competences of the European Union, DeSeCo is of the OECD's list of competences. These sets of competences or the list of competences of the Tuning Project can constitute a good base to ensure the compatibility of the training programs.

To improve the learning and teaching efficacy in the higher education, a valid and reliable measuring tool is needed. Several European projects dealt with assessing student competences. CHEERS, REFLEX and HEGESCO assessed the competencies of the students going out into the labour market while the Tuning project tried to work out a standard measurement of university students' generic and specific competences in Europe. AHELO is an OECD initiative to create a standard measurement tool. AHELO has been built on the CLA (Collegiate Learning Assessment) of the USA and the Tuning project. AHELO assesses generic competences according to CLA and specific competences according to the Tuning project. [6]

In Hungarian higher education there isn't a standard assessment of student competences. That's why our research aim was to develop a new and reliable measure of competence which can be used easily. Our other aim was to assess the incoming students' competencies to promote their learning efficacy during their education.

2. Method

The four measurements were made between 2010 and 2013 with our freshmen (n_{2010} = 407, n_{2011} = 541, n_{2012} = 432, n_{2013} = 496). The proportions of participants were between 84% and 92% compared to the population of freshmen. The proportion of faculty sub-samples (*Table 1*) was similar in every year (χ^2 = 10.62, p = 0,100).

Table 1. Frequencies of sub-samples by year

	FMEA	HF	TF	Sum
2010	276	97	34	407
2011	374	113	54	541
2012	297	93	42	432
2013	338	90	68	496

For the assessment of above mentioned fields we have developed an on-line test and a questionnaire. The software was available in intranet environment.

In the first year we have used 200 items for a detailed diagnosis of cognitive components (thinking, numeracy, problem-solving and communicational skills, memory). The test was reliable (Cronbach's α = 0.88), but the time need of it was more than two hours.

From the second year we shortened the cognitive test to 124 items by a regression model (*Table 2*). The short variant of the test preserved the structural coherency of tasks and sub-tests (Cronbach's α = 0.90).

Table 2. Number of items and reliability of two test-variants

	Original	Shortened
Reading	32	16
Writing	18	9
Systematizing	30	9
Skill of abstraction	32	32
Comprehension of logical interconnections	28	21
Inductive thinking	29	12
Problem solving and numeracy	11	5
Verbal memory	20	20
Reliability	0.88	0.90

The questionnaire contained five sub-scales of self-reflection (8-11 items each): communication, use of the native language, reading, cognitive skills and self-efficacy.

It is possible to fill the shortened variant of the test and the questionnaire in 70 minutes.

3. Results

The results of cognitive fields were similar in every year. In order to compare our results from different years, we have transformed our variables into a 100-point scale.

The aggregated score showed a normal distribution (e.g. in 2013: Kolmogorov-Smirnov Z = 1.041, p = 0.229) with a medium average (between 58 and 62 points) and a medium standard deviation (about 10 points). So the test results could show the individual differences in cognitive performance.

The proportion of those who could not reach the level of 50 points was between 7 and 10 percent. We presupposed that they faced serious handicaps in more cognitive fields. For them we have organized some developmental programs in order to reduce their lag.

We have found significant but small differences among the averages of faculties (e.g. in 2013: x_{FMEA} = 63.8; x_{TTF} = 57.4; x_{HF} = 59.2; ANOVA F = 21.40; p = 0.001; *Table 3*).

Table 3. Average of the results of cognitive fields

	FMEA	HF	TF	ANOVA *F*(*p*)
2010	62.1	60.0	58.8	2.79 (0.094)
2011	57.7	59.5	60.7	5.35 (0.005)
2012	68.0	65.0	63.9	10.4 (0.001)
2013	63.8	59.2	57.4	21.4 (0.001)

Results of all subtests were transformed into a 100-point scale. The evaluation of the results was based on the standards of the subtests. Most of standards originate from the public education.

The average of our students' inductive thinking (e.g. in 2013: x = 54.9) is significantly lower than it is known from national standards of grade 11 (x = 57.2). [10] A quarter of our freshmen showed lower performance on this subtest.

Numeracy and problem-solving skills in the sample were significantly more underdeveloped (e.g. in 2013: x = 40.7) than they were expected. We have measured significant differences in problem-solving among our three faculties in every year. FMEA students' average was significantly higher than at the other two faculties (e.g. in 2013: ANOVA F = 48.79; p < 0.001).

The deficit of these important components can cause serious difficulties in learning. That is why our College has decided to create the above mentioned developmental programs.

Our findings in other domains can be considered to be average. We have not measured any significant differences between our freshmen's result and the national standards. This fact is not giving us a chance for easy teaching, because the sample of the national standards contains all kind of students (not only the prospective students).

As it was expected, the cognitive domains were correlated. The subtests has showed medium or strong correlation with the total cognitive performance (r = 0.221 - 0.630).

The individual differences in each fields can affect to the differences in aggregated variable of cognitive performance. These effects were measured by a regression model. The aggregated variable of cognitive performance was the dependent variable and the results of cognitive subtests were independent.

Skill of abstraction has a significant role in the total cognitive performance according to the regression analysis ($r\beta$ = 0.22 – 0.25), but memory and problem-solving were also important in the explanation of variance ($r\beta$ = 0.13 – 0.17). As a sample, the effect of independent variables in 2013 is shown in *Table 4*.

Table 4. Regression analysis of cognitive variables in 2013

Dependent: aggregated variable of cognitive fields	
Independent variables	$r\beta$%
Reading	10.2
Writing	4.9
Systematizing	10.0
Skill of abstraction	22.3
Comprehension of logical interconnections	8.9
Inductive thinking	13.4
Problem solving and numeracy	16.3
Verbal memory	13.9

The average level of self-reflection domains moves as it is known from psychological studies. Each subscales of self-reflection have a small role in the explanation of variance of the suitable cognitive components. It means that the vast majority of our students can not reflect properly on their skills.

This deficit in self-reflection is very problematic. As the researchers of motivation signed the self-reflection and self-image are very strong motives of learning. These motives can affect the learning performance significantly in a positive or negative direction. So the teaching of self-evaluation is one of the most important fields of our developmental programs.

We cannot measure differences among the faculties of our college in affective variables.

4. Discussion

Our result signed that the college education has to emphasize on the development of the cognitive skills and self-evaluation. The development may happen as a part of our developmental courses (its name is "*Learning of learning*"). But the traditional courses also may contain the elements of the development. Well-known interactive teaching methods, such as project method or cooperative learning can improve cognitive and social skills. These methods give a natural chance for self-evaluation and group evaluation. Additionally, the success of these learning situations can improve our students' motives.

5. Conclusion

The research accomplished its fundamental aims: a reliable, easy-to-use on-line test and questionnaire was prepared. They are suitable for the assessment of necessary fundamental competencies in the higher education. Based on the results, we can draw up developmental programs for our students from year to year.

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COMPETENCES FOR THE SUCCESS OF STUDENTS LEARNING IN DUAL TRAINING SYSTEM: THE FIRMS' VOICE

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Abstract
The Dual Training System has been used in Europe for 25 years; however its popularity has just begun to grow in Hungary. The international literature shows the advantages of it, and parallel with it tries to collect the problems and find answers, too. In our program we are building a system with methods and tools to operate the best long-term pedagogical and psychological co-operative program. We think that there are well-functioning methods to make a good working team, in which the partners can find the solutions for effectiveness.
To improve the work-efficacy we must consider what the key factors are in the pro-cess. We think the students' competencies are one of the main factors. To improve the efficacy of dual training we should develop our students' generic and specific competencies. This work splits between the two partners of the dual training, both the college and the firms take part in the development, so it is essential to harmonise their work in this field. To pro-mote it, we conducted a focus interview with the representatives of firms which take part in the dual training in Kecskemét College. Our research aim was to get acquainted with employers' perceptions of the students' competencies. The representatives of the firms set out and grouped the most important competencies which are needed at the firms, and told us how satisfied they are with those competencies in case of our students.
Our research was the first step in the harmonisation of the work of Kecskemét College and the firms that take part in dual training. On the basis of our research results we can work out a plan of co-operation for the sake of the success of dual training.

Keywords:
dual training, higher education, competences

1. Introduction

The role of knowledge as economic value has been increased in the knowledge-based society. For a decade experts of Economics and Education have tried to define what kind of knowledge and what kind of competences are needed in the future society. One of the main issues of European educational researches is how to change the education to make it more effective and together with it to define the teachers' new role [1].
It is well known that the vocational training should adapt the fastest and the most effectively to the changing economic and social requirements. High quality vocational training, especially with a strong focus on work-based learning, can smooth the students' transition from education to the labour market and it can reduce the ratio of unemployment of young people [2]. That is why the most urgent is the reform of training, and the reform of teacher training, so as to make the teachers capable for renewal [3]. German researchers dominate the researches on dual training due to the success of dual training system in Germany, but the most frequently quoted reference is from Great Britain [4]. Most of the studies examine the operation and forms of the system, roles in the system and quality assessment, but this field hasn't got into the focus of main stream educational – psychological researches so far. So our study is important from this aspect as well.
Our situation is special from several aspects as we prepare and work on the training of the teachers who are involved in the renewal in the vocational education in higher education. We take the concept of teacher in a broader sense; we use it for all the experts who meet students during their education. The situation is special because both in the college and in the workplaces several experts take part in the students' training who are not teachers by profession that is they do not have educational – professional qualification. On the other hand, according to Clark, the characteristic of the training is that boundaries expand and contact, zig and zag, across time and space [4], and this is a great challenge for all who are involved.
The efficacy of the dual training can be developed only if all participants follow the same guidelines, set the same aims, and the system is based on CDPA cycle with continuous information exchange (Figure 1).

Figure 1. JEED Education and Training Guidelines. Source: Japan Organization for Employment of the Elderly, Persons with Disabilities and Job Seekers. https://www.jeed.or.jp/english/implementation_of_vocational.html

There was a shortage of well-trained engineers in the western part of Germany in the 1960s. By the middle of the 1970s the first form of dual education was set up due to the cooperation of educational policy makers and industrial companies. In the 1990s the dual training was practiced not only in vocational training but also in higher education. Later some other European countries followed the German example, for example Austria, Switzerland, Denmark, The Netherlands, etc. [5]. The dual education system has been practiced in form some years now in China and some other countries in Asia. In Germany, especially in the southern regions, this model is also used for a special college system called Duale Hochschule. In France dual education (formation en alternance) has undergone a boom since the 1990s, with information technology being the greatest draw [6].
To ensure the necessary number of professionals for the dynamically developing automotive industry and its suppliers is a greater and greater challenge in Hungary. There is a shortage of well-trained engineers who are well trained, can communicate in a foreign language and have sufficient professional practice. The dual training in Hungarian higher education has undergone a boom since 2010, especially in education of engineers and in cities where big German car factories has settled and started to work (Győr, Kecskemét).
Kecskemét College followed the example of Duale Hochshule Baden-Württenberg which has cooperated with Daimler-Benz and Bosch since 1970. The most important characteristics of the model are that this form is beneficial for both the companies and the students, the students spend less time in the higher education institute, but more time at the companies and firms. The educational form is flexible and can be adapted to the needs of firms. The theoretical and practical knowledge is harmonized to deepen the students' knowledge, and the price of the training is shared between the performers of the society and industry. So the dual education system has advantages for the economic performers, students, the state and the higher education institution. [7].

2. Methods

Our main aim is to harmonise the work of the firms and the college in order to improve the efficacy of the training. To improve the efficacy we must develop the students' competencies. That's why we wanted to explore the employers' views about dual training, the possibilities and problems they face. We studied their perceptions of student competences and tried to map their expectations. With this research we prepared the development of a methodological toolkit which promotes the cooperation of the training partners and establishes the quality enhancement. We describe the first steps of the long term research.
To explore the employers' representation of dual training and students competences we used qualitative methods. We conducted a focus interview with the representatives of the firms which take part in the dual training of Kecskemét College. 12 representatives of 8 firms took part in the research.
The numerous terminologies made it necessary to revise the concepts and define competencies precisely and set the goals of vocational training in dual-system.
The confirmation of the methodological apparatus was made using the qualitative catalogue of criteria [8]. The catalogue's essential concepts are presented in the light of the current research using a methodological schema from a qualitative research [9]. The main concepts are the following:

- *Documentation of the researcher's point of view*: leaders /representatives of firms were asked to participate in a 2,5 hour long occasion. Convenience sampling was used.
- *Documentation of the process of data collection*: the participant were asked to write down their ideas about competence, the main reasons of their own success; the most important competences of students taking part in trainings.
- *Empirical restrictions*: we did not give hypotheses before our research, instead of it we framed open ended questions according to qualitative concepts. After the exercises we made data-analyses with manually coding, and then we did open and axial coding.
- *In order to ensure the validity of the qualitative research*, the method of *triangulation* was used.

Fulfilling the idea of personal triangulation, in order to minimize the subjective effects the research were made by two of us. According to methodological triangulation, it is advised to use various methods; however, we decided to use only the method of reflective diaries, as this method reveals inner thoughts and overcomes technical and time barriers. Upon data triangulation, data was gathered from various concepts of firms, then the elaboration and the analysis of these data were done separately by the two of us and the results were compared at the end.

- *Indication of the methodological decisions and the analysis*: data collecting and analysing methods suit to each other; the research was in harmony with the sources, information and aims.
- *The research questions* are relevant, it is very important for our education in college

3. Results

The first part of the interview focused on the participants' concepts about the professional success through their experiences of their own professional success. We think that people perceive the world through their personal filter and as a teacher they transmit those values which are identical with or close to their own beliefs.

We got interesting results by axial coding and two-dimension arranging of the text of the interview (Table 1.) in relation with both the content and analysing the cross categories separately. After the analysis of the participants' carriers when we assessed the competences and traits we found mostly affective factors. The most basic factor of the professional success could be identified with difficulties on the basis of its components, it may be defined as innovation competence or attitude.

We examined the employers' requirements from the students who get to their firms during the training with a three-step brainstorming method. The mechanical engineers and the technical managers worked separately, the results were compared in an oral discussion. In the first phase all the participants wrote down 3-5 student competences which are very important from the aspect of employers. In the second step they form groups and set up a competence structure. The last step was the comparison of the competence structures and the discussion of the most important competences. According to the results the following competences are the most important from the employers' point of view: technical interest, motivation, concern for quality, communication, ability to work independently.

Table 1. Criteria of success highlighted in the carrier analysis of the representatives of economics

	Competences			
Factors	personal	cognitive	social	professional
Affective	- hard working - endurance loyalty - openness	- curiosity - continuous development	- forming good (work)team	- finding a job suitable for their interests - passion for technology
Cognitive		- versatility - problem solving - continuous learning		
Complex	*Innovation competence* - adapting to new situations, reception of new things - new activity - renewal - „Walking up the little professional steps"			

In our research we analysed the results on the basis of the individual concepts of the first step by coding them. Having compared the requirements of the two profession groups, the consensus of focusing on the basic competences and the different way of thinking in personal competences and personality traits can be detected (Table 2a; 2b; 2c.)

Table 2.a The mechanical engineers requirements toward the students

Main	Economic sense
personal	hard working, endurance, loyalty, patience
cognitive	*Theoretical knowledge and its affective background* (thirst for learning, effort/need to develop); *Practical knowledge*: usable professional knowledge, *Communication* (knowing a foreign language, terminology, communication in a foreign language) *creativity*
social	*entrepreneurship* (responsibility, decision making, courage) *ability to work in team* and motivation ability to cooperate openness flexibility
professional	*Professional motivation* - interest in the profession, professional cooperation, love for the profession, - technical interest, - enduring the different work phases, - professional calling, - being motivated, - technical sense, - walking through the steps of the technical process,

Table 2.b The technical manager requirements toward the students

Main	Basic professional knowledge
personal	- *Self-confidence, ability to work alone*, being assertive - Fantasy, creativity - high requirements toward themselves
cognitive	- *exactitude* (consistency, *thinking systemically*, efforts for order and systems, being precise - *Practical knowledge:* using theories in practice, deeper knowledge about the business processes of the firm, ability to concentrate) - *Communication: knowledge of a language* (usable foreign language knowledge)
social	- *Culture* (general behaviour norms, greeting, setting examples, reading comprehension, linguistic literacy, soft skills) - *ability to work in team* o practice in team work, o cooperation in team,
professional	*Professional motivation* - interest in the profession, enthusiasm, - love for profession, his or her work is his or her hobby, - respect for the professional humility, - endurance - will to learn

Results of comparison (2a and 2b)

1. *Personal:* *Different*
2. *Cognitive:* Mainly similar (same: practical knowledge and communication*)*
3. *Social*: Partly identical (*ability to work in team and attitude)*
4. *Professional*: Identical

4. Discussion

Comparing the results of the discourse of the economic representatives and qualitative coding and systematization, it is obvious that it is worth collecting data with different methods. Comparing the five most important competences defined by the participants with our analysis it can be seen that technical interest and (professional) motivation, which can be found on the first two places on their lists, and communication were interpreted differently from several aspects by the two groups, although concern for quality wasn't mentioned in the required competences neither directly nor indirectly. The exact skills can't be seen which are required in this field so there won't be any possibility to map them or to develop them until it is made up.

5. Conclusion

Towards the development of the training we should feature a usable competence system based on our results, and it will constitute the standard basis for the theoretical and the practical training.
Our experiences – and the participants' feedback- prove that our methods and technics are suitable to explore the representations of the competences and requirements toward the students which were in the centre of the focus interview. The discourse based cooperation was fruitful for both partners.

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CHALLENGES AND OPPORTUNITIES IN THE DUAL TRAINING MODEL AT KECSKEMÉT COLLEGE

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Abstract
In our lecture we give a presentation of the developed and introduced dual training model at the Faculty of Mechanical Engineering and Automation (GAMF), Kecskemét College. The practice oriented type of dual training was launched at the Department of Vehicle Technology for BSc students in September, 2012. At present in addition to the BSc training in vehicle technology dual training is available for mechanical engineers (BSc) as well as for engineering managers (BSc). After defining the concept of dual training we would like to emphasize its social, economic and educational importance. Up to now 13 partner companies take part in the training representing different industries, thus giving countless opportunities for our future engineers. This new form of training faces several methodological challenges both for the participants of tertiary education and our partner companies. According to this training model students are not only trained within the college but skilled company experts and engineers play a very important role in their training as well. In many cases engineers and experts of companies lack educational qualification and teaching experience. Thus, dual training involves pedagogical and methodological challenges. In order to achieve a successful methodological improvement a research has been carried out to exploit the pedagogical, methodological skills among the contributors of dual training. With the acquired results we wish to develop education aiming at a practice based trainers' training. The aim is to introduce the participants of dual training interactive, new and comtemporary forms of methodology besides classic forms of teaching.

Keywords:
dual training model
methodological challenges
trainers' training

1. Introduction

The Kecskemét College dual training model in higher education is a system during which the students complete half of their practical training within their studies at a given company. The biggest difference between the traditional undergradute training and dual training is that students acquire theoretical knowledge and related practical training in real-world conditions and learn to use it. Thus, industrial companies gain a type of workforce with fresh Bsc degree who is able to enter the world of work immediately [1].

The practice-oriented dual training is a defined type of training in many (mainly western) European countries. Kecskemét College used the well-known German type of dual training as a model,- the Duale Hochschule Baden-Württemberg model [2]. Dual training has deep roots in Germany both in the fields of secondary vocational education and of higher education. One of the most important task and aim in German vocational education is to deliver and improve professional knowledge. The constant high-level industrial development required the training of an appropriate number of highly skilled experts. This aim could only be achieved and realized by a highly qualified academic staff, advanced infrastructure moreover, by establishing workshops meeting the high standards of technology. All of the above listed requirements were met by the industrial companies joining the German dual system.

The introduction of the training at the faculty of GAMF (Faculty of Mechanical Engineering and Automation), Kecskemét College was urged by Mercedes-Benz Manufacturing Hungary Ltd settled in Kecskemét in 2009. This alternative form of training is attractive and appropriate both for the students and the joining industrial companies. Its characteristic is that it has been developed by taking into account the needs of enterprises ready to respond fast to the changes in labor market. The practice-oriented dual training was launched first in vehicle engineering in September 2012 with the participation of two world leader companies: Mercedes-Benz Manufacturing Hungary Ltd and Knorr-Bremse Fékrendszerek Ltd.

The popularity of this training can be experienced by the vast interest shown by several universities, colleges and industrial companies. However, with its introduction a number of challenges, moreover, economic, educational and social expectations have emerged.

One of the key elements of the dual training is that the base theoretical knowledge is acquired at the college while students through real life tasks gain experience at the different enterprises. Furthermore, it is important to mention that the strongly academic knowledged based institutions' curricula do not or just partly contain the development of different social skills and their application in practice, which dual students simultaneously obtain at companies. During the 7-semester-training period the students study half at the College and study and work half at the company. The students enter into a contract of employment, which contains the allowances and their sum, dates of annual leave, the expected learning outcomes and the conditions for the termination. Students are exposed to a stronger pressure, however, regarding motivation and academic achievement the results are clearly positive (Figure 1 in Appendix).

On the part of industrial companies in Hungary the need for well-prepared professional engineers have appeared, as, companies seek for well-qualifed and trained workforce at today's labor market. Moreover, high professional knowledge should be coupled with the acquisition of soft skills (communication skills, negotiating skills, knowledge of foreign languages, giving a presentation, group work). From a company' aspect professional recruitment should be emphasized as students become competitive engineers within the walls of the company adapting the company's work culture and image. This can save the costs that would arise if the company should look for inexperienced workforce or workforce with little professional experience in the labor market, then educate and train them. The company consciuosly builds up the practical training of students synchronizing it with the academic curriculum of the College. A strong attachment and commitment to the company can be detected from the very beginning among the students. (Research show in Germany on average 80% of the graduates of DHBW Stuttgart are taken by their training company after graduation [3]).

The Hungarian higher education system also needs a change in the fields of training as today it has several drawbacks. The various engineering courses provide a strong academic knowledge, which lack the appropriate number of hours spent on practical training. Moreover, college professors have moderate industrial practice, the number of professionals coming from industry is low. In addition, the subjects do not fit the expectations of the industry, many higher education institutions face serious shortage of financial resources, and in many cases are forced to teach in outdated, ill-equipped workshops and laboratories. The dual training is able to provide a solution to these serious problems with the unity of the academic and practical knowledge.

Another fact should be considered in favor of dual training which is none other than the expectation of the society. Contemporary society requires a flexible, high quality, relatively short-term (3-4 years) training from higher education institutions. Today's economic and technical development need highly skilled workforce in all areas of social life. The companies train partly at their expense the professionals according to their own future needs in workforce. The has an impact on society as local needs are met locally. A trained workforce serves the labor market of the given area, replaces the shortages of skills. Another important aspect of society is that the majority of students would like to be a dual student at a company, which is located close to the place of residence. This may make areas more attractive for settling down, later having a family thus reducing labor migration.

The growing number of students and companies show the popularity of dual training. While dual training started with 20 students and two companies in 2012, the following year new courses - BSc in Mechanical Engineering and Technical Management specializing in logistics - started training students. In 2013, 13 companies and 71 students took part in dual training. With the constant growing interest the number of companies rose to 24 in September 2014 and together with the first year students the number of students taking part in dual training is 127.

The significant increase in the number of students and industrial companies urged us to set up a centre in 2013. the Dual Training Methodological Centre. This centre is responsible for the flow of information between companies, students, and college professors as well as for communication and coordination.

2. Assessment of dual education based on the experience of business professionals attending the training

To be more effective in the dual training a continuous discourse is essential between companies and the College. In addition, it was important to know the views and the experience of those professionals who took part in the training of dual students in the previous periods. A questionnaire using open-ended questions was compiled which included the strengths, weaknesses, opportunities and risks of dual training. The questionnaires were returned completed from 15 people from 10 companies: 12 male, 1 female, and two individuals did not provide information on their sexes.

Among the ***strengths*** the following were mentioned by most: the possibility of gaining high-quality and professional work experience, learning to work in a team, the acquisition of up-to-date

technical knowledge, workplace guarantee and the chance to build professional relationships.
"Practice-oriented training built on industrial experience. Students get to know high-technology."
"Understanding common experience up close, there is a possibility to get an insight into the details of daily work and correlation. Students are made to work in team thus, creating a community."
"At the end of the training the companies already get to know the students thus they can be placed in position easier."
It can be seen that business experts formed different opinions on strengths which are important for the company from economic point of view emphasizing the importance of practical experience and workplace culture as well as integration.
Among the ***weak*** points the yet not sufficiently developed teaching materials and their coordination between the companies and the College are mentioned. Engineers imperfect knowledge of pedagogical skills were also mentioned here. The following points were also commented: due to lack of teaching experience taking part in educating the students requires much time besides daily work, moreover, students inadequate background knowledge can be argued as well.
"Companies do not have a well-practised training theme, we face teaching deficiency and inadequate qualified teachers deal with students."
"Coordination of curricula betwen College and training sites. Little capacity can be given to students."
"I would mention as weakness the difference in knowledge gained at the College and in the course of training. "
The ***possibilities*** then arise by themselves as experts aim at eliminating the weaknesses. Companies recommend to insert the companies' needs to the curricula, moreover, to get companies to coordinate the themes of the practical training with each other. Companies should also name the managers and people being in charge of the training. In addition they see an opportunity to train practical management skills.
"Unified practical education theme for the companies."
"Exchange of experience between the academic teachers and training instructors, appoint dedicated business professionals."
"Thinking together more often; discussion between companies; electing more motivated students; urriculum development;study trips."
The training is considered to be ***risky,*** if it only focuses on one specialized field, and is adapted to only one company's needs. Among the risks the difficulties with the students' schedule are mentioned especially during the examination period. If too much changes are made it can make it more complicated. The company can also take an economic risk if the student will not take a job with the company after graduation.
"There is a big difference between company and company, it is difficult to achieve the same quality practical education."
"If students migrate, it was a waste of money."
The collected data on SWOT analyses with the help of the questionnaire show that the companies take their mission very seriously and are eager to join this training full of new challenges for them, students and the College.

3. The challenges of teaching methodology in dual training

The dual form of training faces a number of methodological challenges in higher education for and corporate partners. The training of students does not only take place within the College thus, the business professionals, engineers play a great role in the professional and practical transfer of knowledge. However, they do not normally have educational qualifications and teaching experience. Hence, the dual training includes pedagogical and methodological challenges.
Engineers, business professionals taking part in dual training mentioned educating with the absence of pre-training in pedagogy as weakness. Kecskemét College has also detected this problem and within the project of TÁMOP-4.1.1.F-13/1-2013-0019 „Development of the Kecskemét Dual Training Model in the local region in the highlight of automotive industry and in the service of creating a successful national economy and society" we undertook to initiate pedagogical and methodological trainings for the participating business experts. To ensure the effective training research has been conducted to reveal the pedagogical and methodological knowledge of the business experts, as, the transfer of skills within dual training can also be interpreted as a pedagogical task.
Only one person out of 15 respondents have educational attainment. This data is very important for us because we wish to adjust the academic and practical syllabus of the training of trainers' to the participants pre-knowledge and experience. If company professionals have no experience regarding methodology, it is absolutely necessary to include pedagogical basic knowledge in the curriculum.
We had a look at the type of training courses the professionals dealing with students took part in in the last five years. Typically, everyone participated in a training course most commonly in professional ones. This was followed by communication and presentation trainings. It is not surprising that only three have participated in a methodology training since it is not common for industrial companies to

educate even to the extent to associate a training with it (Figure 2 in Appendix).
Assessing the needs of business professionals we found that they would participate mostly in trainings aiming at methodology and educational technology, as well as trainings on developing teacher competencies and terminology (Figure 3).

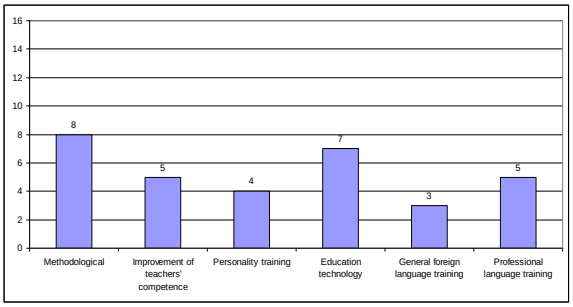

Figure 3. What methodological help would you require to have dual training more effective?

We wished to know the methods currently being used by professors (Table 1).
According to the answers everyone uses individual, group and pair work (15, 12 and 10 people), as well as individual and group consulting (11 and 9). In the process of evaluation the joint assessment of students reached the highest value (10 people). Lecture, presentation, projectwork, and the use of cooperative methods were less typical. Students giving presentations, preparing a portfolio, discussion and student self-assessment is not typical either. The provided data show the practical nature of the applied methods as professors apply group and individual work.

Table 1. Teaching methods currently being used by professors

	Yes	No	Not answered
Lecture	8	4	3
Teacher presentation	4	5	6
Groupwork	12	0	3
Pairwork	10	2	3
Individual work	15	0	0
Individual student presentation	3	7	5
Group presentation	4	7	4
Projectwork	7	4	4
Cooperative method	7	3	5
Making portfolios	1	8	6
Discussion	6	4	5
Teacher assessment	7	3	5
Joint assessment with students	10	1	4
Student self-assessment	5	5	5
Group consulting	9	2	4
Individual consulting	11	0	4

4. Conclusion and future prospects

The dual training is a form of renewal of higher education which success can be contributed to with the renewal of teaching methods and its innovation. With the results of our research we wish to develop a teaching method based on practice for the training of trainers. This method will introduce the participants to an interactive new generation type of methodology based on the classic form of explanation and frontal students' work. The reviews and suggestions of business professionals help us develop the training and its future.
The experience of the past two years have clearly demonstrated that the dual training at Kecskemét College is successful and should be continued. However, there are still areas which should be improved, developed and changed in the future.
Primarily the economic and legal background for institutionalization of the training should be achieved. Within this framework the terms and conditions will be defined. The standardization of the training has begun in the form of a Handbook, which sets the training process step by step.
Regarding corporate partners a national organisation will take part in the accreditation of the companies specifying the conditions with respect to quality, technology and professionals under which an industrial company may join the dual training. In order to develop the integrator method successfully in today's higher education system it is necessary to fulfill the above conditions.
Extending the training in two other fields, Information Technology Engineering and Faculty of Horticulture, are also among the future plans of Kecskemét College.
As a conclusion the interest towards dual training model of Kecskemét College is being beyond expectations. Kecskemét College has develep and improve this training so as to be able to respond to the new challenges of labormarket. In the future the reform of higher education should contain dual training in order to give highly-qualified engineers who with a well-based academic and practical knowledge can be a full workforce at the labormarket.

Acknowledgement
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Appendix

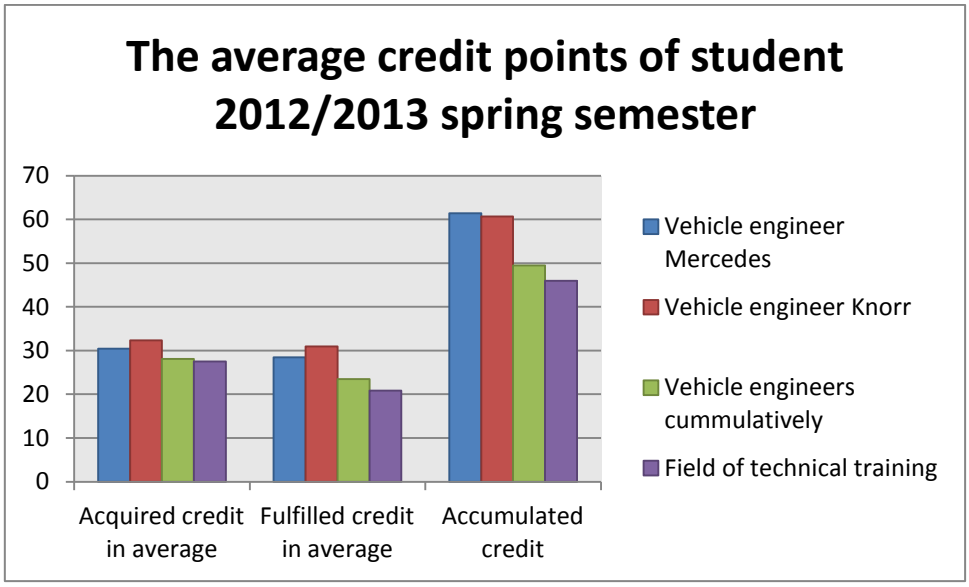

Figure 1. The 2012/2013. The average of acquired, fulfiled and accumulated credits in the spring semester (Dr. Erika Török, Dual Training Model Workshop, 2014 April, Kecskemét College)

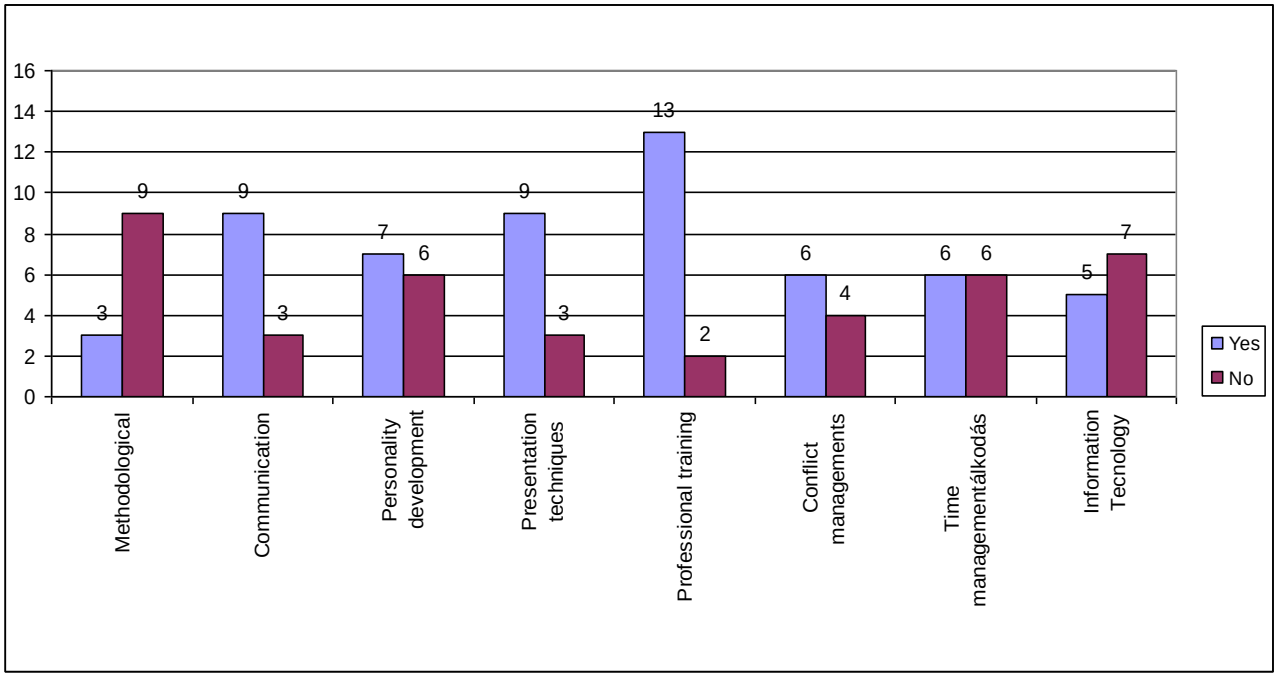

Figure 2. What kind of trainings did you attend in the last 5 years?

ESTABLISHING NEW COURSE FOR THE EDUCATION OF SENSORICS AT THE GAMF FACULTY OF KECSKEMÉT COLLEGE

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Abstract
In this paper the construction of the new course titled "Physics of Sensors" is discussed, which is presented for the students of informatics, specialized at industrial informatics. New student laboratory sessions have been created from scratch, as no educational materials distributor sells pre-built practical courses in this field. The students meet experiments that familiarize them with basic sensor circuitry and the use of modern compact industrial sensors, and are implemented in a manner encouraging further experimenting at home.

Keywords:
sensorics, sensor education, physics of sensors

1. Introduction

The educational plan 2010 for the students of informatics at Kecskemét College introduced the course "Physics of Sensors". The goal of this course is to familiarize the students with the physical basics of the sensors used in the field of industrial informatics, including the conditions and limits of their usability and it gives skills in carrying out and evaluating physical measurements. The course consists of lectures and student laboratory work, both 2 classes weekly.

2. Lectures

As the guide literature of the lectures, a recently published comprehensive textbook in Hungarian of the field has been chosen [1], with complementary literature containing vehicle sensorics [2] and industrial proximity sensors [3].
The individual lectures include the following topics:
1. Basic concepts: characteristics of sensors, sampling and digitizing, static errors of sensors, hysteresis. **2.** Sensor circuits, transducers, drawing symbols. **3.** Temperature sensors. **4.** Force and torque sensors. **5.** Pressure sensors. **6–7.** Position and proximity sensors **8.** Angular position and rotation rate sensors **9.** Acceleration and momentum sensors **10.** Flow meters and gas sensors **11.** Sound sensors and dynamic properties of sensors **12.** Picture sensors.

3. Student laboratory sessions

The laboratory exercises are carried on in small groups of 2–3 students, mostly 4 groups per class. Due to the very small size of our student laboratory, there is no room for storing the equipment of the same experiments in multiple instances, which necessitates that each group works on different exercises in a rotational manner. The students must prepare for the laboratory sessions from the syllabuses handed out, and the first chapter of the laboratory protocol (title page, names, equipment list, measurement principles etc.) must be written in advance. The protocol must be handed in at the end of the session.
The exception is the introductory session (labeled here as **0.**), when the students process simulated data in a computer lab, practicing for the measurement results of oncoming exercises.
0. Work safety training. Measurement errors, and the laws of error propagation. The basics of regression calculus. Evaluating measurements.

All experiments are “home brew” of our department, because it was not possible to find sets of pre-built laboratory sessions in the field.

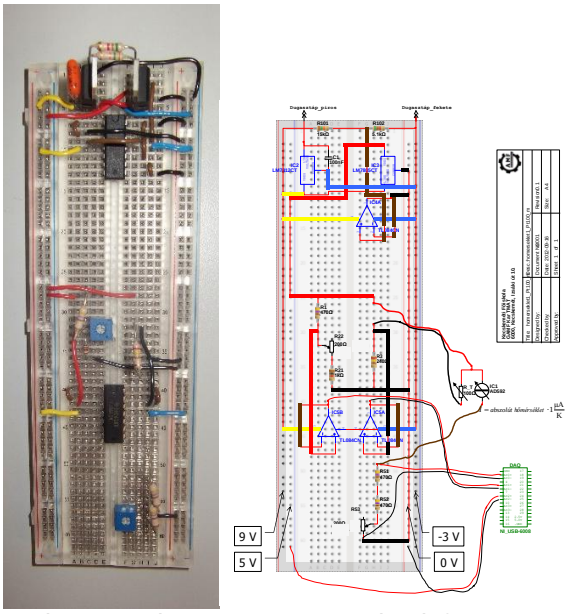

*Figure 1. The measurement circuit for Pt100 investigation (session **1.**)*

The circuits of the experiments are implemented on protoboards in order to be easily assembled and repaired, using wire coloring for perspicuousness (e.g. Fig. 1.). The powering of the circuits is solved by simple wall-plug supplies, of course with the necessary voltage regulation as the first building block on the protoboard.
The syllabuses show the circuit diagrams evolving from basics to the actual implementation at the end, with the same wire and resistor coloring in the same arrangement (e.g. Fig. 1.). We think that both the simple, solderless realization, that focuses on the circuit scheme, and the issuing of the evolution steps embolden the students with less soldering skills to experiment outside classes for the sake of just their own curiosity.
1. Temperature measurement with resistance thermometers: familiarizing with the measurements carried out by digital acquisition cards and LabVIEW, and the usage of the Pt100 and the AD592 sensors. Comparison of the measured data from the two sensors, and determination of the sensitivity of the resistance thermometer (Fig. 2.).

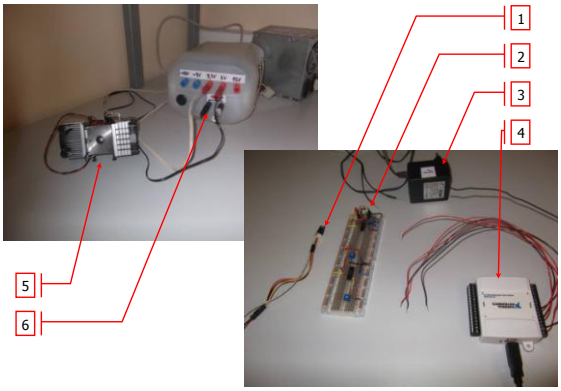

Figure 2. The test stand for investigating the resistance thermometer

This experiment and the following has many common features, including the sensing head, consisting the sensor to be investigated (Pt100 in this case, #1 in Fig. 2.), and an AD592 temperature transducer IC for reference, the heating–cooling body operated by QC-K03504T125 Peltier-elements (#5, same Fig.) and its driving power supply (#6. same Fig.). Two pairs (serially connected pairs) of Peltier-elements in parallel consume approximately 3 A current at 3,3 V, which is difficult to serve with the linear power supplies pre-available at our department, that's why we decided to recycle old ATX (switching mode) power supplies which can deliver much more power (150–200 W) at fixed, regulated voltages. The available higher voltages made it possible to operate the fans on the heating–cooling body in cooling mode, too.

Such home-built power supplies also show the students, how easily they can supply their private experiments even with relatively high current requirements.
The main parts of the circuit (#2 in Fig. 2., detailed: Fig. 1.) are a Wheatstone-bridge that converts the varying resistance of the Pt100 into voltage, and a sense resistor, that enables us to measure the current signal (1 μA/K) of the reference sensor also as voltage.
The voltages are measured automatized during the heating and cooling process by a simple NI USB–6008 DAQ-card (#4 in Fig. 2., shown as green standalone circuit element in Fig. 1.), for which task a simple LabVIEW virtual instrument was coded (Fig. 3.).

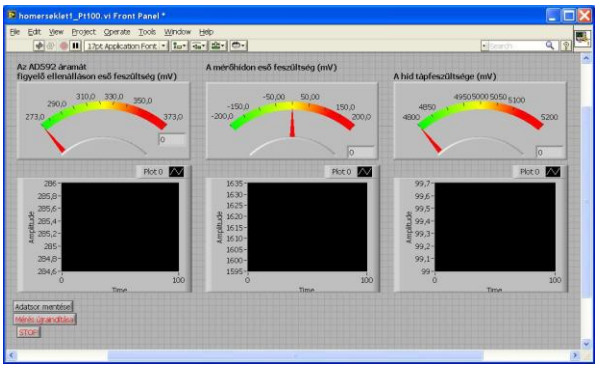

Figure 3. The VI to visualize and log the acquired data from the resistance thermometer and the reference sensor

In the end the students must cross-calibrate the Pt100, that is graph the resistance vs. temperature graph, and determine its slope.

2. Temperature measurement with thermistors: getting acquainted with the usage of the thermistors and the AD592 sensors, using DAQ-card and LabVIEW again. Comparing the measured data from the two sensors, and determining the characteristics of the thermistor.
The test stand is very similar to the previous one (see Fig. 4., the legend numbers are the same too), with the exception, that the sensing head consists of a thermistor as the element to be investigated, and a simple current generator and a sense resistor is used to transform the thermistor resistance into voltage signal (Fig. 5.).
The measurement process is the same, automatized (Fig. 6.), but in the end characteristics must be linearized according to the B-parameter equation, and the B-parameter must be determined (which is the reciprocal of a slope in this case, too; of the linearized graph)

3. Bridge circuits: comparison of the sensitivity of the quarter, the half and the full Wheatstone bridge. Getting familiarized with the usage of the FSR-149AS pressure sensors.

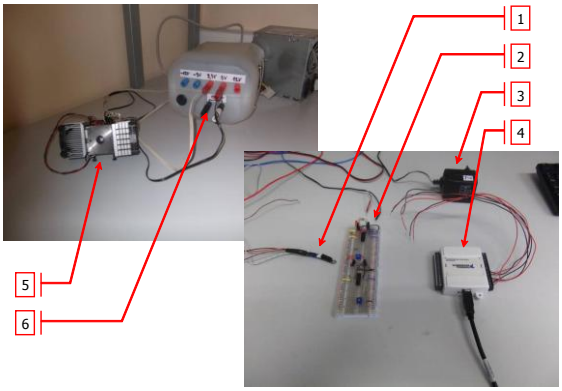

Figure 4. Measurement setup for the thermistor investigating lab session

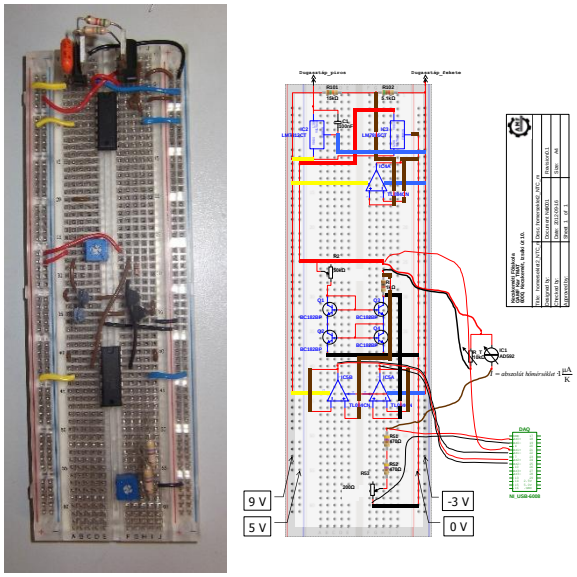

Figure 5. The measurement circuit for thermistor investigation

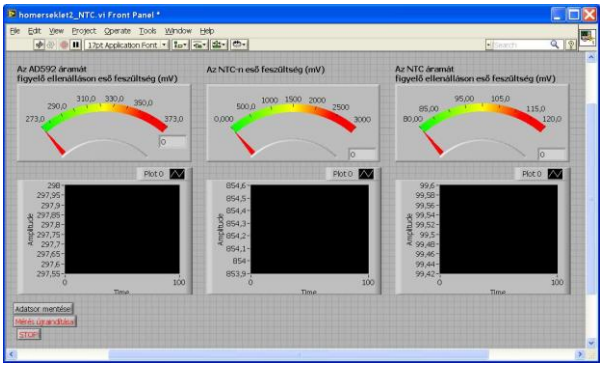

Figure 6. The VI to visualize and log the acquired data from the thermistor and the reference sensor

The resistance of the pressure sensors decrease as the force on them increases. We use four of them, each is under the leg of a small table, whose top is transparent (#5. in Fig. 7.; being of glass, which necessitates extra safety warnings in the syllabus) that enables the students to place the legs exactly in the middle of the sensors. A 500-g mass (#6 in same Fig.) can be placed in different positions in the middle line of the table, which varies the forces exerted by the legs.

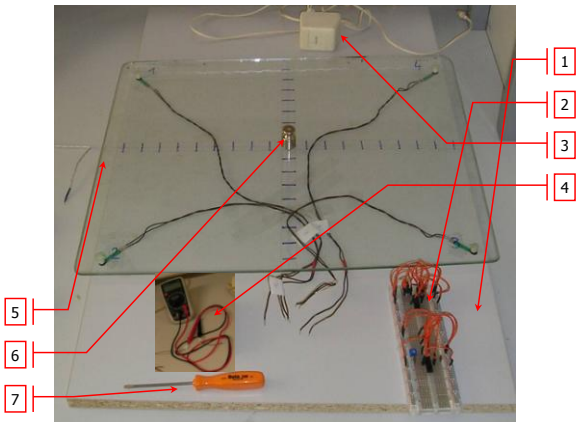

Figure 7. Test stand for the quarter, half and full bridge circuit comparison exercise

The bridge circuit (#2. in Fig. 7.) can contain either the sensors or fixed resistors. The students must assemble several quarter and half bridges, and one full bridge, measure (in this case by a digital multimeter, #4. in same Fig.) and graph the voltage–mass position relation, determine the sensitivities (slopes), and find the correct conclusion, that is, the sensitivity of the half bridge is the sum of the sensitivities of the quarter bridges, and the sensitivity of the full bridge is the sum of the sensitivities of the full bridge approximately.

4. Comparing the 2- and 3-wire bridges: investigation of the influence of the environment temperature on the two bridge types. Familiarizing with the usage of the MLO-POT-300-LWG potentiometric displacement encoder (Fig. 8.).

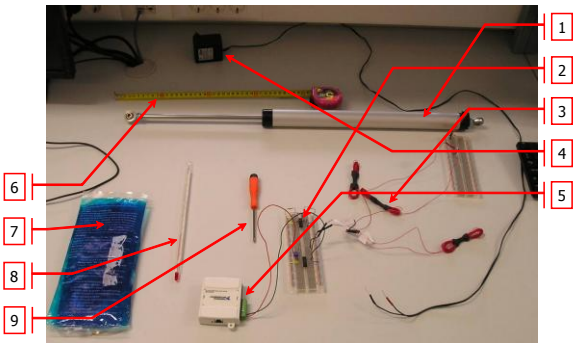

Figure 8. Measurement setup for comparing the 2- and 3-wire bridges

The two ends of the displacement encoder can be fixed through bearings to two point in a structure (much like a cylinder with piston rod, #1 in Fig. 8.), and when the distance of points increases or decreases, the piston moves outwards or inwards, respectively. The piston moves a 5 kΩ

potentiometer, whose resistance can be measured through its terminals.
The resistance is measured by a quarter Wheatstone-bridge again, but this time the displacement encoder can be hooked up both in 2- and 3-wire configuration (#2 in Fig. 8., detailed: Fig. 9.) through 4-m long, thin aluminium wires (#3 in Fig. 8.).

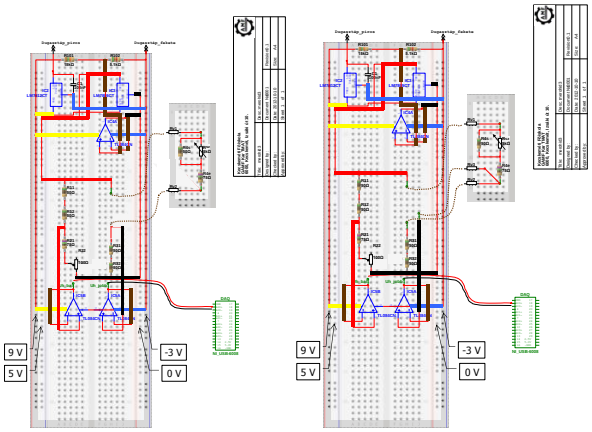

Figure 9. The 2- and 3-wire bridge circuits

The resistance of the long wires change, when their temperature is varied, which is done by wrapping them in hot or cold ice gel (#7 in Fig. 8.), imitating a sensor connected to a Wheatstone-bridge by wires running outdoors under varying ambient temperature.
The students must measure the bridge voltage vs. piston rod length characteristics of both bridge configurations with the wires at three different temperatures: at room temperature, wrapped in cold and warm ice gel. They must find the correct conclusion, that is, the characteristics is affected less by temperature changes in the case of the 3-wire Wheatstone-bridge.

5. Measurement of fluid level and hydrostatic pressure: practicing the usage of the MPX20DP differential pressure sensor, and the instrumental amplifier circuit. Determining the pressure–voltage characteristics (Fig. 10.).
The sensor has two pressure inlets (#1 in Fig. 10.), one of which is connected to a pipe (#5 same Fig.). If the fluid level at the other end is *h* deep under the surface of the fluid in the bottle (#6 same Fig.) of density ρ, then the gauge pressure in the pipe equals the hydrostatic pressure of the fluid column of height *h*. As the other pressure inlet is open, meaning that the pressure sensor is in gauge pressure mode.

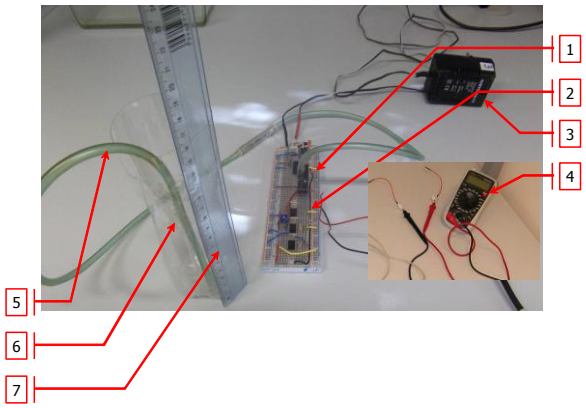

Figure 10. Test stand for the measurement of fluid level and hydrostatic pressure

The change of the measured unamplified voltage signal is very low (0.025 mV/mm of water column), so an instrumentation amplifier is built on the measuring circuit (#2 in Fig. 10., detailed: Fig. 11.).

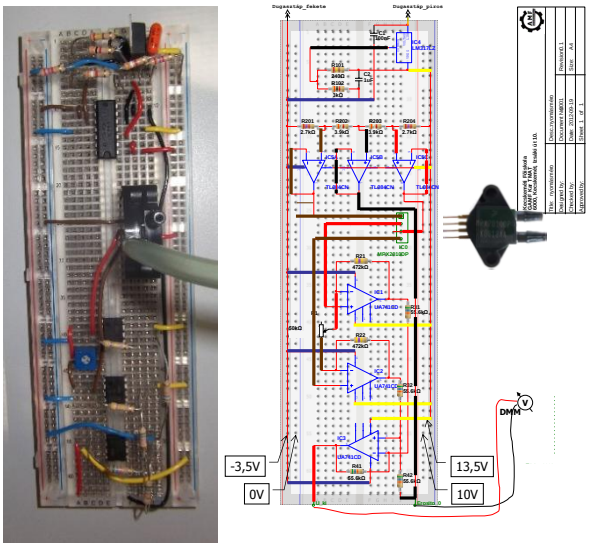

Figure 11. Sensor and instrumentation amplifier circuitry for the pressure sensor experiment

The students must measure (by digital multimeter, #4 in Fig. 10.) and graph the amplified signal as the function of the water column height, and determine the sensitivity of the whole circuitry (sensor+amplifier) at three different settings of the instrumentation amplifier. Having calculated the amplification, they must provide the sensitivity of the bare sensor, too.

6. Capacitive proximity sensing: getting acquainted with the properties of the proximity sensors based on capacitive principles and with some applications of them (Fig. 12.).

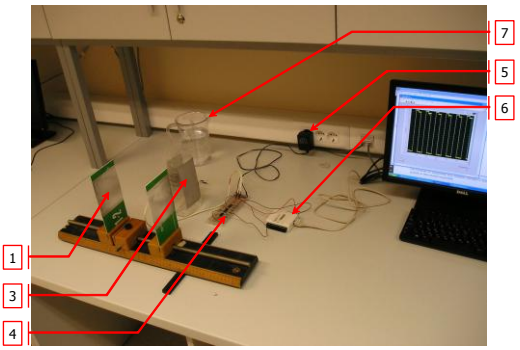

Figure 12. Measurement setup for the capacitive proximity sensing lab session

The students carry on experiments with two circuit elements with position-dependent capacitance. The capacitance is connected into a circuit (#4 in Fig. 12., detailed: Fig. 13.) consisting of an oscillator based on a 555 timer IC.

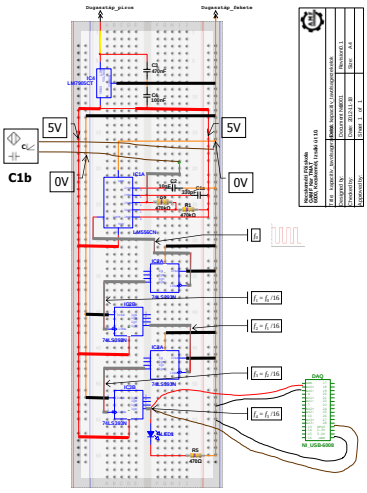

Figure 13. Implementation of the capacitive sensing circuit

The first device tested consists of a large capacitor (#1 in Fig. 12.), and between its armatures several sample materials can be moved on rail. The students move the sample between the armatures, and record, and finally graph the position dependent frequency of the oscillator.
The oscillator square-wave output is measured by an NI USB-6008 DAQ-card (#6 in Fig. 12.), and its signal is processed by a LabVIEW virtual instrument (Fig. 14.), that both visualizes the signal, and calculates its frequency.

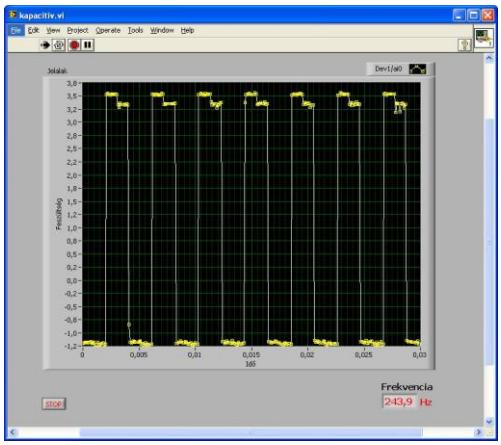

Figure 14. The VI to visualize the oscillator output, and to measure its frequency

As second device, the students use a bottle with capacitor armatures on the outside (#3 in Fig. 12.). The students record and graph the oscillator frequency as a function of the water level in the bottle.
7. Magnetic proximity sensing: getting familiarized with the properties of the industrial proximity sensors based on magnetic principles using Festo-SMEO Reed-switch (Fig. 15.a and d), Festo-SIES inductive proximity switch (Fig. 15.b and e) and Festo-SIEA analog signal inductive sensor (Fig. 15.c and f).

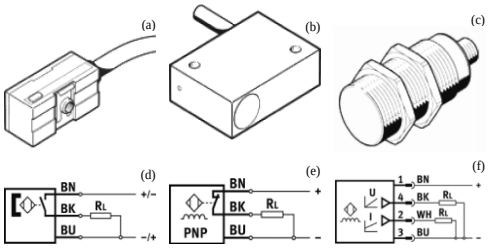

Figure 15. The three magnetic proximity sensors used in the lab session

The students mount the magnetic proximity sensors and the samples on the opposite jaws of a vice (#6 in Fig. 16.) which allows the tuning of the distance between them. In the case of the Reed-switch, the samples are 1, 2 and 3 blackboard magnets. The simple voltage regulator and LED-signaling circuit allows them, to set the switch-on and switch-off distance between the Reed-switch and the varying quantity of magnets, which finally can be measured with a caliper. No complex sensor circuit is needed as the devices investigated are highly integrated, compact sensors.

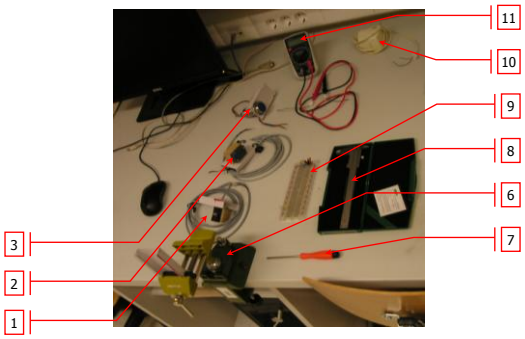

Figure 16. Test stand for the magnetic proximity sensing exercise

The same measurement procedure can be followed for the inductive proximity switch and the different metal samples (aluminium, copper and brass).
In the case of the analog signal inductive sensor, the voltage signal vs. distance can be measured with a digital multimeter (#11 in Fig. 16.) and plotted. The students must come to the right conclusion, that the materials with higher specific resistance can be sensed from greater distance.

8. Optical proximity sensing: familiarizing with the properties of the proximity sensors based on optical principles using Sharp-GP2Y0A02YK (Fig. 17.a and c) and Festo-SOEG-RTD (Fig. 17.b and d).

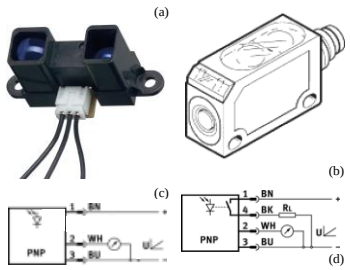

Figure 17. The two optical proximity sensors used in the lab exercise

The students mount the optical proximity sensors and the samples (metal, wood, plastic) on rails (#4 in Fig. 18.) which allows the tuning and the readout of the distance between them. In the case of both sensors the output voltage of the sensor vs. the distance can be measured with a digital multimeter (#7 in Fig. 18.) and plotted.

4. Results

Since 2012 the course was taken by 52 students, of whom 51 fulfilled it. The number of grades is shown in Table 1. The histogram of the students' final score in percent is shown in Fig. 12. The average score of the individual lab sessions in percent is shown in Table 2.

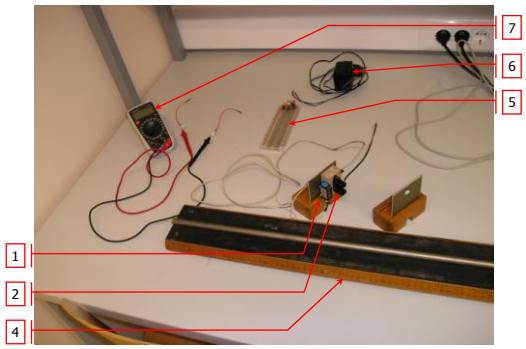

Figure 18. Test stand for the optical proximity sensing exercise

Table 1. Number of final grades

Grade	# of students
1	0
2	0
3	19
4	17
5	15
Not fulfilled	1

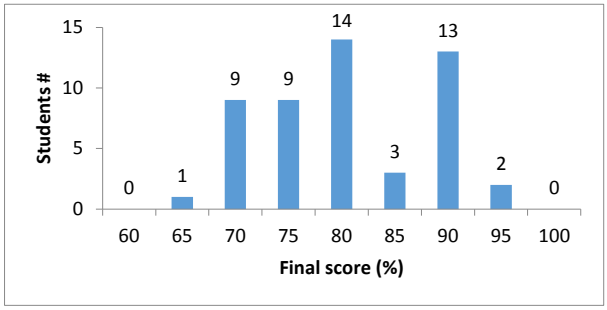

Figure 19. Histogram of the students' final score in percent

Table 2. Average score of the individual lab sessions

Session topic	Average score (%)
Resistance thermometer	70,5%
Thermistor	80,0%
Comparing the ¼, ½ and full bridges	83,0%
Comparing the 2- and 3-wire bridges	78,3%
Pressure and fluid level measurement	95,7%
Capacitive proximity sensing	97,8%
Magnetic proximity sensing	99,6%
Optical proximity sensing	100,0%

5. Conclusions

The course has been established successfully, as shown in the results. Further work must include educating other (e.g. mechanical and vehicle engineering) students, conducting students' scientific (TDK) activities, and creating further

laboratory sessions both for meeting the demands of other engineering science fields and for having sessions as reserve in case some setups go wrong.

Acknowledgement
The acquisition of the student laboratory equipment was financed by the Training Support applications of the GAMF Faculty in 2010, 2011 and 2012.

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ACTION RESEARCH-BASED INNOVATION IN TEACHERS' PROFESSIONAL DEVELOPMENT AT KECSKEMÉT COLLEGE TEACHER TRAINING FACULTY

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Abstract

*ISIT („**I**mplementation **S**trategies for **I**nnovations in **T**eachers' Professional Development") builds on a well-evaluated programme for teacher professional development (BaCuLit) with six training modules which all serve the literacy development in the subject area classrooms of secondary schools: Content Area Literacy (CAL). The acronym **BaCuLit** stands for „**Ba**sic **Cu**rriculum in Teachers´ In-Service Training in Content Area **Lit**eracy in Secondary Schools." Within this program an instructional framework for professional development was developed in cooperation with renowned Content Area Literacy-experts and institutions of teacher professional development from the USA and 7 European countries. This framework consists of 6 modules, closely connecting theory and practice. This programme was translated into 6 national languages (German, Dutch, Portuguese, Romanian, Swedish, Hungarian), put to the test in 7 teacher training institutes (one of them is Kecskemét College Teacher Training Faculty) for the target group, evaluated (formatively) and eventually edited in an optimized final version.*

ISIT aims at supporting the introduction of such training into the regular programmes of the participating institutions for in-service teacher training in three European countries: Germany, Hungary, Romania. At the same time ISIT aims at developing a research strategy to identify the key factors of success for an implementation of innovation into advanced teacher training. One project aim is a broad embedment of the programme in European teacher training institutes.

The participants will be qualified as certified BaCuLit trainers through a 3-month blended-learning course and a 1-week international summer school licensing them to offer professional development programmes based on the BaCuLit materials. They commit themselves to document and reflect this „implementation process" of CAL-elements (or entire BaCuLit courses) in their institution by means of a semi-structured research logbook. An action-research approach will provide the methods to be followed.

Keywords:

Content Area Literacy, blended learning course, teacher professional development, action research approach

1. Introduction

The ISIT project addresses two of the crucial needs defined by the Education and Training Benchmarks for 2020 and by the High Level Group of Experts on Literacy (HLGEL 2012):

a) the problem of low literacy skills in many European countries

b) the unsatisfying status of teachers' continuous professional development (CPD) in the EU.

Thus ISIT pursues **two goals**:

a) a specific goal: training 30 teacher educators from 3 European countries in content area literacy (CAL)

b) a general, comparative goal: analysing good examples of how to implement innovations into different national structures of CPD.

The innovative aspect of the project is to effectively combine these two goals.

The project follows a multiplier approach: by training teacher educators (narrow target group) it will reach out to secondary school teachers (second target group) which will have a positive impact on the long-term target group of students with low literacy skills (broadest target group).

ISIT builds upon the results of the Comenius project BaCuLit prodiving a comprehensive curriculum in CAL for CPD, including course materials and trainer handbooks. ISIT aims at implementing this concept into the CPD structure of Germany, Hungary and Romania, where a total of 30 teacher educators from 25 different training institutions will be made familiar with CAL instruction.

The project follows an action research approach, which means not to separate research from action. Therefore the trainers will analyse together with scientists the steps and obstacles in implementing CAL courses in their institutions. Thus, ISIT intends to explore the general opportunities and obstacles in implementing innovation into teachers CPD in these 3 countries.

A further objective is the dissemination of CAL into 5 other countries: partners from Belgium, Cyprus, Finland, Greece, and Portugal will participate gaining comparative insights and providing input from the perspective of their countries.
The ISIT participants:

1. **Coordinator: University of Cologne (UCO),** Prof. Dr. Christine Garbe, Dr. Andreas Seidler, M.A. Martin Gross
2. Core Partners (Germany, Hungary, Romania):
   - **Germany:** Experts for Continuous Professional Development of Teachers from the Federal State of Hessen
   - (**Hungary:** Hungarian Institute for Educational Research and Development **(HIERD), Budapest,**
   - **Hungary:** Kecskemét College **(KeCo),** Kecskemét, Prof. Dr. János Steklács, Dr. Ildikó Szabó, Dr. Veronika Szinger
   - **Romania:** „Alexandru Gavra" Teacher Training Center, Arad **(CCD Arad),**
   - **Romania:** Filocalia Foundation **(FiFo),** Iasi,
   - **Romania:** Romanian Reading and Writing for Critical Thinking Association **(RWCT),** Cluj-Napoca
3. Associate Partners:
   - **Belgium:** University of Liège (**ULG**),
   - **Cyprus:** Centre for the Advancement of Research & Development in Educational Technology **(CARDET),** Nicosia,
   - **Finland:** Jyväskylä University **(JyU),** Jyväskylä,
   - **Greece:** Aristotle University Thessaloniki **(AUT),**
   - **Portugal:** University of Minho **(UMinho),** Braga.

2. Scientific background of the project

BaCuLit has been designed as a reaction to the problem of low achievers in the EU. "Performance on reading literacy of young people deteriorated in the period to 2006. Most recent data for 2009 show a good improvement which is, however, not sufficient to meet the target for 2010"[1]. [1] It means, more effective ways of schooling and instruction have to be developed. In some European countries only mother tongue education in elementary schools serves as reading instruction. On the contrary, the idea of content area reading (reading to learn) and 'reading across the curriculum' has to be fostered.
The other main problem is that the 'selective principle' within the educational philosophy of some European school systems is hindering the realization of effective support systems for all students. According to BaCuLit philosophy, the idea of the support principle combined with the use of formative assessment in instruction has to be fostered.
For improving instruction in the medium term, in-service teacher education is most necessary and the most effective practices of in-service teacher education need to be tried out. *One-shot activities* or *short scale approches* have almost no sustainable effect on classroom practice. Teachers' routines and beliefs are often stronger than new ideas and concepts. Therefore, there is a gap between what teachers know and what they do (‚knowledge-action-gap').
For overcoming the ‚kowlegde-action-gap' *long-term approaches* are needed that involve coaching teachers continually over a longer time period. Teachers try out in actual school contexts what they learned in the training and form professional learning communities which offer support and foster commitment and accountability.
Blended-Learning approaches seem to be appropriate for teachers´ professional development because time and personal and financial ressources are used in an optimal way.

3. Methods and objectives

European reports about the conditions of Teachers' Professional Development (like TALIS or Eurydice 2011 and 2012) offer valuable data concerning teachers' professional development in European countries on a general level, which form a reliable frame for orientation, but they do not provide advice for the central question of this project: Which strategies for the *implementation of innovations* are suitable for the respective educational systems? As to this question we need more specific qualitative data which can be obtained best by means of "action research", which closely links theory and practice according to the principles of "learning by doing": Action research is conducted in natural (e.g. educational) settings „in an ongoing cycle of planning, acting, observing, and reflecting on change". Central principles of action research are *not* to separate research from action (change, innovation) and likewise *not* to separate researches from actors. "Action research is examining one´s own practices through collaborative inquiry, reflection, and dialogue[2]". It has been known by many names including participatory research, collaborative inquiry, participatory research, action learning. In a nutshell it means that teachers thoroughly examine their everyday practice, pose problems and try to find solutions to those problems through collaboration, dialogues and reflection. "It is not just about

[1] www.alinet.eu

[2] Nugent et al. 2012, p. 4

hypothesizing and collecting data. It aims at changing situations; not just interpreting them[3]".
The project consortium will accompany 30 teacher educators from 25 training institutions (in 3 countries) while they integrate CAL courses (offers) into the existing CPD activities of their institutions.
ISIT based on the assumption that experiences with implementing CAL are valid and helpful also for other kinds of innovation. Thus they can be used by all actors who want to implement new methods, materials or subject-related focuses into CPD.

Two work stages are planned (identical with Work Package 1 and 2):
• **Implementation**: (**Training of the trainers)**: In every core partner country an Information Day was organized to address the decision makers within teachers' CPD institutions. Measurable Indicator: The Info-days served the aim to invite teacher trainers to a training course in CAL. The Hungarian Info-day took place at HIERD on 23 January 2014, and was attended by highly qualified professionals from HIERD, higher education institutions, research centres, pedagogical institutes.
The training of the trainers took place in a national blended-learning course consisting of 3 months E-learning and one common international summer school.
• **Exploitation:** Partly overlapping with this training course the 30 trainers started planning the integration of CAL elements into the regular programmes and services of their institutions. On the basis of a semi-structured report form they write an implementation logbook documenting the steps they take and the obstacles they face. These logbooks will be analysed and summarized by the national coordinators and discussed on national level (follow-up-meeting) and finally at an international meeting.
The project aims at:
• a specific (pedagogical) objective: the qualification of teacher educators in CAL (on the basis of the BaCuLit model curriculum)
• a more general objective related to education policies: exploring and identifying successful strategies for implementing innovations within CPD.
Specific objective: Establishing CAL in secondary school teachers' professional development. In Germany, Hungary and Romania a total of 30 trainers from ca. 25 different training institutions will be made familiar with the BaCuLit curriculum and its standards. This will enable the trainers to flexibly use CAL elements in their training of teachers in their region. It is supposed that by this multiplier effect about 500 teachers per year will be made familiar with CAL elements and will be encouraged to use them in classroom practice of all disciplines and all school ages. Baculit is to be understood as a model of a training programme for teachers; but we are well aware of the fact, that trainers have to adopt it to current requirements, programmes and time frames. Thus implementing a fixed training programme is not an aim, but to train the trainers in flexibly adopting its standards and materials.
General objective: A Comparative Study – based on case studies in different countries - of "Innovation Management" in CPD. The project accompanies 30 trainers and their institutions while they try to implement CAL elements into their regular training programs and services. The according steps and the obstacles will be analysed in order to come to conclusions about implementation strategies in CPD.
In the ISIT project these strategies are related to the implementation of CAL, but it is assumed that similar strategies could be applied in implementing other innovations. Thus these conclusions will be helpful for all actors in CPD. As a result a Comparative Study of the gained experiences will be presented, accompanied by suggestions for implementing innovation in teacher education processes in the participating countries (in 4 languages: English, German, Hungarian, Romanian, extent about 100 pages).
Dissemination into 5 other countries will take place. Although the project focuses on three countries, partners from 5 other countries participate, in order to gain new and comparative insights and to give input and advice from the perspective of their countries. These "corresponding partners" are from Belgium, Cyprus, Finland, Greece, and Portugal. They are to attend two project meetings in teams of scientists and teachers.

4. Workplan and Work Packages

Work Package 1, Month 1 – 6: Training of the Trainers

- One-day Information Seminar – in each country 15-20 representatives from education authorities and training centres. Topics: (1) Report on the state of international research on reading with regard to CAL, (2) Discussion of implementation methods on the ground, (3) Invitation to the qualification of trainers
- Training of Trainers via Online Platform (www.itslearning.com), for each (of the 3) country, 10 trainers shall be trained in a blended learning course. Months 3-6: materials and tasks to be provided via an online platform
- Training of Trainers at an International Summer School: a 5 day international

[3] Nugent et al. 2012, p. 6

summer school took place, for all teams, including the associate partners, in Germany.
- Outcome (total): about 30 trained teacher trainers in 3 countries.

Work Package 2, Month 10 – 12 / 5 - 10: Exploitation

- Month 5-10: Trainers work out a plan for implementing CAL in the general curriculum of their institutions. Deliverable: implementation logbooks (about 25 on a whole) in the national languages, being summarized by national project leader.

Questions for the Implementation Logbooks:
The central topics for the logbooks will be prepared in common report forms worked out by the coordinating team. They will consist of questions like:

- How, on the basis of the available resources, can CAL be integrated into the regular course programme and support services of my institution?
- How should the BaCuLit curriculum be adapted to the national / regional conditions of CPD in my institution?
- How can the teachers of the region be motivated to take part in the CAL training?
- How can additional funding for the CAL offers be secured?
- How can the support of the responsible authorities (if applicable: accreditation) be achieved?
- Each national project group leader writes a report about the implementation process in English
- The project leader writes an international comparative report (draft, about 100 pages) (month 10/11)
- **Month 11:** Meeting of the project partners to discuss the national reports and the draft of the international report
- **Month 12:** Finalising the report.

Work Package 3: Dissemination (Associate Partners, Multipliers)
Objects of dissemination are:
Firstly: CAL elements for CPD programmes (presented in the form of the model-curriculum BaCuLit).
Secondly: the results of "action research" in implementation strategies for CPD programmes.

The project focuses on the issue of dissemination options in European teacher training. Therefore dissemination activities have begun with the Info Days, attended by the heads of CPD institutions (15 persons in each country).
The training of trainers can also be understood as dissemination. It communicates skills and materials for CAL training to a clearly defined target group that consists of 30 trainers from three countries.
In a wider sense, dissemination is aimed at all CPD institutions and teacher trainers in 8 European countries (Germany, Hungary, Romania and 5 corresponding partners). This wider target group is approached in two ways: participation of corresponding partners and publications.

5. Conclusion

A final international workshop in month 11 will present the outcomes of the project to the international partners, incorporate their feedback and discuss their support for international dissemination. At the same time ISIT aims at developing a research strategy to identify the key factors of success for an implementation of innovation into in-service teacher training (action research).

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DEVELOPING, IMPLEMENTING AND PILOTING INTERACTIVE TEACHING RESOURCES IN A EUROPEAN CONTEXT

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Abstract
In today's infocommunication society interactive teaching and learning processes making access to and process of information easy both individually and on community platforms have gained a crucial importance in schools. The number of media pedagogical researches in the field has been increasing. Having reliable literature on the theoretical input behind these current practical applications is also very relevant.
This study is about a multilateral mediapedagogical innovation that aims to contribute to the above mentioned goals. The authors refer to the scientific background of the topic, then introduce INTACT – Interactive teaching materials across culture and technology – a European educational cooperation and collaboration on how to apply interactive teaching and learning processes in bilingual educational settings.

Keywords:
interactive teaching and learning resources, bilingual educational settings, cooperation and collaboration, CLIL, online platform

1. Introduction

INTACT - *Interactive teaching materials across culture and technology*- develops cooperative and collaborative teaching and learning resources that can be applied for CLIL (Content and Language Integrated Learning) instruction and, through the use of an online platform, are made available over cultural borders.
The scientific approach in INTACT is based on educational research or action research. The experts develop based on current –scientifically approved – educational approaches specific learning scenarios and materials. These scenarios and materials are tested in 'real life' classrooms, evaluated and improved. The continuing peer review processes of all involved partners ascertain the quality of the scenarios and materials as well.
The project addresses the secondary schools' need for reliable interactive resources, to be used in Science, Mathematics and Social Science classrooms in CLIL educational settings. Environmental issues and intercultural questions are also focal points for the development of the interactive resources.
The main requirements for the development of the interactive teaching resources are as follows: interactivity, compatibility and independence from specific technology, easy access, bilingual and intercultural aspects, social and collaborative learning as well as flexibility and adaptability.
The INTACT-consortium consists of six higher education institutions from different European countries: University of Education, Ludwigsburg (Germany), Universidad Complutense Madrid (Spain), Kecskemét College (Hungary), St. Patrick's College, Dublin (Ireland), Polytechnic Institute of Bragança (Portugal), Babes-Bolyai University, Cluj (Romania).

2. Scientific and research background of the project at the Hungarian partner

The scientific basis of the project is the results of mediapedagogical researches on international and national field. We mention firstly the project *iTILT* (*Interactive Technologies in Language Teaching*). The project provided results of interactive teaching methodology with technology for different languages, proficiency levels and age groups from seven European countries, helping teachers gain confidence with technology in communicative language teaching. We have to mention the results of the project EuSCRIBE too. The members wrote the Guidelines for effective school/classroom use of interactive whiteboards.
Kecskemét College Teacher Training Faculty as the research center of INTACT-project in Hungary and Kecskemét Calvinist Primary School as the practice school of the project have been taking part in various European projects aiming at promoting and developing foreign language competences that are relevant to INTACT.
One of the previous projects that can be regarded as a point of departure is Pri-Sec-Co. The project (Pri-Sec-Co - Primary and Secondary Continuity) had as its main aims and objectives to raise awareness for the problem of transition among the teachers and teacher trainers, exchange experiences, collect models of good practice and

design bridging tasks in the field of FL which could facilitate transition between the two educational levels. Furthermore, the project aimed to design teacher training courses on the subject of transition (Lipóczi 2011).
As an outcome of the project bridging tasks were developed to be used to facilitate the transition from primary to secondary school. The bridging task from Hungary was „Buildings and activities in my town" designed for pupils learning German as a foreign language in the primary and the secondary level.
The other project in the field was MOLAN „Network for the exchange of information about good practices that serve to motivate language learners". MOLAN had the goal of exploring, analyzing and then making accessible to large public examples of successful initiatives in the field of language learning within primary and secondary schools. Kecskemét Calvinist Primary School represented the only good practice from Hungary within this project. This school initiated bilingual education using CLIL method, which was in the focus of an Erasmus program, CulTiFoLa as well. The school was asked by Gáspár Károli University (the Hungarian partner of the program) to function as the practice school of the international students involved in the program (Szabó 2012).
Taken all this research and project background into consideration, the Hungarian partner of INTACT-project meets all the requirements of the project.

3. Methods and objectives

The scientific approach in INTACT is based on educational research or action research. Experts in their fields i.e. science education in primary schools develop based on current –scientifically approved- educational approaches specific learning scenarios and materials. These scenarios and materials are tested in real life classrooms, evaluated and improved. After the evaluation proves the scenarios and materials are working well, they will be published and made available for everybody to use.
The continuing peer review processes of all involved project partners ascertain the quality of the scenarios and materials as well.
Interactive, CLIL teaching and learning resources for various subjects are created during the project's duration. Educational resources are developed for the following disciplines: Biology, Geography, Civilization, German as a Second Language, Mathematics and Engineering. A wide spectrum of cooperation for schools by communication and collaborative work with the use of interactive materials will be achieved on regional, national and international levels facilitated by an INTACT online platform.
The main topics/requirements for the development of the interactive teaching resources are as follows: interactivity, compatibility and independence from specific technology, easy access, bilingual and intercultural aspects, social and collaborative learning as well as flexibility and adaptability.
Target groups and users of the interactive teaching and learning resources are teachers and students in primary and secondary schools with bilingual instruction (CLIL). Each partner cooperates with at least one pilot school. Researches of the partner institutions and teachers of the pilot schools develop the concepts for the teaching and learning resources cooperatively. In a subsequent phase the resources will be tested at the pilot schools and, with consideration of the results, will be revised accordingly.
The project is divided into four main working areas. Each area corresponds to one of the project's main themes and consists of individual working packages. Essential and comprehensive project decisions are discussed in the steering group, which includes the national leaders of each partner. In addition to the entire project's project management and the steering group, three other project groups exist. One or two project partners, so called group leader, manage each of the groups. The group leaders are also responsible for the included workpackages.
Group 1 (WPs 3 & 4) All aspects of dissemination and exploitation of project results are assigned to the first group. This includes design and implementation of the logo, website, flyer, and advertising materials for the project. In a further step, the results, among other things, will be provided in the form of an e-book, handbooks and glossaries as well as presented and distributed to events and conventions. The Polytechnic Institute of Bragança (Portugal) is responsible for this area of operation and the corresponding project group (Group 1). *Group 2*. (WPs 5, 7 & 9)The second project group is responsible for three work packages. These three work packages correspond to three work phases during the duration of the project. The project group work includes all aspects that have to do with teaching and learning resources. This concerns conceptualization and implementation of teaching and learning resources. This part is managed by both St. Patrick's College, Dublin (Ireland) and the Babes-Bolyai University Cluj (Romania). Later on there will be tests with follow-up evaluations and, resulting from this, a revised version of the implemented teaching and learning resources. Responsible partners for these activities are Kecskemét College (Hungary) and the Universidad Complutense Madrid (Spain).

4. Results and outcomes

The development of the INTACT teaching and learning resources as well as the educational requirements for the online platform were sequentially processed in a stepwise, collaborative procedure:

1. Deduction of a theoretical framework for the INTACT teaching and learning resources and activities.
2. Construction of templates for the description of the INTACT learning objects, lessons and learning units.
3. Description of the intended goals and the expected learning outcomes as fundament for the evaluation.

The first step for the development of the INTACT teaching and learning resources and for the online platform was an intensive discussion to find a common understanding of (i) the educational setting for the introduction of the INTACT approach (ii) the theoretical, evidence-based framework for the development of interactive and collaborative learning/teaching resources. A result of this first work package was a short-paper as review of the theoretical background and a template for the theory-based development of the diverse INTACT resources in the different related subjects on a primary or secondary school level The second step, the construction of a common template for the description of the INTACT resources, was the result of an intense and partially contentious discussion due to the different cultural and scientific background of the partners in group 2.

The description of the INTACT resources is threefold:

a) Learning objects (LO): As basic component of the INTACT resources, the Los are single digital objects to foster one specific aspect of a topic, e.g. an interactive animation of the human circulatory system, a simulation of the human visual perception under different light conditions or a hypermedia learning environment to discover the life of nocturnal mammals including different format like video, interactive maps or audio-files for primary education. Each learning object is described based on the LOM standard.

b) Lessons: The LOs are included into a lesson. Within the INTACT framework, the lessons are based on a socioconstructivist understanding of learning which fosters a dialogic knowledge and active construction. The description of the lesson plans follows an international standard.

c) Learning units: in most of the cases the lessons are part of a learning unit. The description outline, the intentions of the learning unit, its goals and central educational approaches.

The INTACT teaching and learning resources are developed to be used as learning units, but teachers can also use single LOs as part of their teaching.

All resource descriptions allow setting up a database on the INTACT platform that allows an easy access to the materials including a powerful search engine. Furthermore the INTACT platform will allow a teacher to organize the LOs individually to create, for instance, different micro-modules for heterogeneous classes to provide resources for different abilities.

Recently the following concepts for INTACT resources have been described and partially realized:

- Biology: Immune System; Circulatory System
- Civilization: Legends and Heroes (To be a knight in King Arthur's Court)
- Geography: Climate elements and factors
- German as a second language: Mozart als Kind und seine Reisen
- Primary Science: Creatures of the night; Magnetism
- Mathematics: Construction of triangles
- Engineering: Technical Drawing

The current stage of work is the development of an adequate evaluation plan fitting to the INTACT resource descriptions. The INTACT online platform and the teaching and learning resources will be formatively evaluated with partner schools at all participating countries. Recently the task for the group 2 leaders is to coordinate the schedules for testing and evaluating the INTACT resources dealing with different national curricula and school holidays.

During the project so far the partners have noticed that the focus of the project goes more and more to the online platform and the aligned functional requirements. An important requirement is that teachers can modify and reuse teaching and learning resources, not being forced to use produced ones that might not suite in the curricula or the classroom situation concerning the student's skills and knowledge. Therefore this will be an important issue for the implementation of the online platform.

The online platform's conceptualization and development for the distribution of resources present some challenges. The requirements for this platform are closely related to the resources and the underlying concepts. Because both are developed parallel to one another during the course of the project, a close integration of both areas is necessary.

A further challenge is the determination of which subjects to include in the materials.

Two aspects play a role here. On the one hand, the various partners and partner schools have equally varying interests. On the other hand, there are diverse educational plans within the participating EU countries, and therefore the same class level in different countries requires varying teaching and learning resources. On a related

note, another challenge is developing bilingual teaching and learning resources. Along with an appropriate difficulty level of content, the material must also be at an appropriate level regarding the students' language abilities.

TITLE of UNIT	Legends and Heroes (To be a knight in King Arthur's Court)
KEYWORDS	King, court, knight, medieval times, sword, chivalry, lady, castle, King Arthur, the Round Table
LANGUAGE	English
GENERAL DESCRIPTION:	
SUBJECT COVERAGE	English as a Foreign Language, Civilisation
TARGET AUDIENCE	Primary School (Secondary School)
AGE RANGE	11-12 (A2 CEF level)
CURRICULUM	Bilingual Education Framework, Hungary http://kerettanterv.ofi.hu/
AIMS	To get to know the key incidents of the history in the target country, get familiar with the principles of democracy, current historical and social processes. To learn to respect human rights, religious and ethnic pluralism. To become able to work in groups with cooperative methods, share opinions, respect different points of views, have unbiased discussions. To improve students' self-efficacy, develop their own learning strategies that make them motivated for life-long learning.
NUMBER OF LESSONS	3
DURATION	3 X 45 minutes
REQUIREMENTS	Tablets, IWB
ASPECTS FOR COLLABORATION	Students will communicate in different work forms and situations throughout the lesson. Creative tasks throughout the unit. Lesson 1 LO2, 4, 6: pairs formed from the two national groups to fill in the mind-map, T-chart
DEVELOPMENT OF SKILLS	Communicative, critical thinking, collaborative skills are developed.
CONNECTION	It is a stand-alone unit
CONTENT and LEARNING OBJECTIVES: • to broaden knowledge on culture and history of medieval times; to improve critical thinking (making comparisons between historical periods and cultures) • to enable the child to communicate ideas, present work and report findings using a variety of media	
LESSON 1: Title: *Living in a king's court* Children's vocabulary will be improved through a variety of activities that are suited to meet all different learning styles. They will be familiarised with pieces of clothes, furniture in	

Figure 1. Example of a concept of teaching and learning materials; Living in a king's court

5. Conclusion

The outcomes of INTACT support the following skills and competencies in: communication in a foreign language in the bilingual education, digital competence using digital technologies for the teaching and learning resources, learning to learn by working collaboratively and sharing the learning outcome with other students, social and civic competences as well as cultural awareness and expression by cooperating with other students from other countries when using the teaching and learning resources.

Working collaboratively in a heterogeneous group using a foreign language and sharing the learning outcome with other students beyond cultural boarders advocate social and civic competences as well as cultural awareness and understanding for different cultures.

INTACT addresses the following specific objectives and priorities of EU's Lifelong Learning Programme (Comenius) for enhancing bilingual learning with ICT-based content in schools across Europe:

To promote language learning and linguistic diversity. One important aspect in the project is the bilingual education. Several partners of the consortium are well experienced in bilingual education (e.g. Germany, Hungary) and thereby the bilingual aspects are essential considered in all teaching and learning materials.

To support the development of innovative ICT-based content, services, pedagogies and practice for lifelong learning. The projects implements on the one hand interactive teaching and learning materials in different subjects embedded in bilingual settings. On the other hand the project develops and implements an online platform where the teaching and learning materials can be used across cultural borders.

To develop knowledge and understanding among young people and educational staff of the diversity of European cultures and languages and its value. The interactive teaching and learning resources aim to initiate the collaboration between schools in the region and also across borders. While teachers and students work together on the interactive teaching and learning resources they get to know other countries and learn about country-specific issues.

To help young people acquire the basic life-skills and competences necessary for their personal development, for future employment and for active European citizenship. Learning with the teaching and learning resources in a collaborative situation will be a normal learning setting for students. Students will get into this way of learning while using the interactive teaching and learning resources. The aspects of bilingual education improve the skills of the students in the foreign language, and working together with other countries in Europe will enhance the cultural understanding of the students.

To enhance the quality and European dimension of teacher training. The interactive teaching and learning resources will be spread in the national institution like the Ministry of Education in each country and institutions like Instituto de Tecnologías Educativas in Spain, National Centre for Technology in Education in Ireland, etc.

According to the Europe 2020' strategy the education and training systems in Europe must upon other terms allocate an adequate mixture of skills and competencies, advocating the progress of transversal competences, teach how to use digital technologies and ensure that the citizens have basic skills and that they are motivated and capable of learning (Council conclusions on the role of education and training in the implementation of the 'Europe 2020' strategy, (2011/C 70/01), p. 2).

Within this project teachers and students have the possibility to improve their knowledge in all these areas. From the eight suggestions for key

competencies for the lifelong learning of the European Parliament and Council, six key competencies will be touched on in this project. The following six competences will be discussed in detail: (1) foreign language competency, (2) mathematical competency and basic physics competency, (3) computer competency, (4) learning competency, (5) social competency and civil competency as well as (6) cultural awareness and cultural expression ability.

(1) The foreign language competency will be fostered by bilingual instruction in English and German as well as the different mother tongues.

(2) Mathematical and basic physics competencies will be reached through the development and adaptation of learning materials for the mathematics and science-subject courses.

(3) Computer competency will be facilitated through the application of digital technology for learning materials.

(4) By working in heterogeneous groups and by the exchange of educational findings from pupils outside of the classroom and school organizations, learning competency will be addressed.

(5) Both social competency and civil competency as well as cultural awareness and cultural expression ability, two other key components, will be applied through the communication and cooperation of pupils from various countries and cultural backgrounds.

(6) The project will particularly benefit from cooperation throughout Europe. The development of materials for the lessons especially within the science subjects can be improved with a multi-perspective, international approach.

Combining the teaching of different subjects with bilingual education and the use of digital technologies allows to enhance the skills in a foreign language as well as to improve the digital competencies.

Aside from the usual value of cooperation with international partners this project benefits immensely from the European cooperation. Developing materials for science education incl. environmental and social science issues always improves if different points of view from different nations are considered. The cooperation of the different institutions with their partner schools will help to establish a European network of schools based on the common interest in modern ways of teaching (using interactive technology, bilingual education, and collaborative learning scenarios). Also by working together of educational researchers and pilot teachers the observation of intercultural differences help to sharpen the own viewpoint.

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VALUE RANKING AS A SPECIAL TASK FOR STUDENTS

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Abstract

Value studies have serious traditions in Europe and there are different value-surveys in worldwide dimensions as well. It is always an exciting challenge to repeat any item of European or wider questionnaire in the classroom. Items concerning values offer special tasks, because of the rather subjective content and context of the questions. People seek to demonstrate how the certain values are crucial for them, if we ask simply the importance. At that dimension ranking might help us to force deeper relations behind the order. Some years ago within a European project called ISTEPEC a list of European values has been collected (like peace, freedom, democracy, equity etc.). This study summarizes the result of the students' work on the list given them by the professor. The arguments students used to explain their rankings are much interesting than the simple range given by their answers.

Keywords:

European studies, values, citizenship education

1. Introduction

Value studies have serious traditions in Europe and there are different value-surveys in worldwide dimensions as well.

"The European Values Study is a large-scale, cross-national, and longitudinal survey research program on basic human values. It provides insights into the ideas, beliefs, preferences, attitudes, values and opinions of citizens all over Europe. [1]

The European Values Study started in 1981, when a thousand citizens in the European Member States of that time were interviewed using standardized questionnaires. Every nine years, the survey is repeated in an increasing number of countries. The fourth wave in 2008 covers no less than 47 European countries/regions, from Iceland to Azerbaijan and from Portugal to Norway. In total, about 70,000 people in Europe are interviewed.

World Values Survey (WVS) started in 1981 as a part of the European Values Study and quickly became one of the most widely-used and authoritative cross-national and time-series surveys covering almost 100 societies (nearly 90% of the world's population). A rich academic literature has been created around the original and consecutive surveys and numerous other works have made use of the findings. [2] In-depth analyses of the 1981, 1990 and 1999 findings with regard to Western and Central Europe (included Hungary since 1990), and North America reinforced the impression that a profound transformation of modern culture is taking place, although not at the same speed in all countries. Cultural and social changes appear dependent upon the stage of socio-economic development and historical factors specific to a given nation. The new 2008 wave provides further insights in this matter."

2. Work with values

It is always a challenge for a teacher to repeat the questions of international surveys among students even the sample definitely will be incomparable. This study is trying to summarize the possibilities of classroom work with the items of different examinations, especially the ranking values. In the middle of the 1990s I asked more than hundred students by questionnaire if they like or not, or if they feel important or not certain thing, values and factors (like money, respect, politics etc.) around them. As a consequence of the big sample the description of the result showed a certain order and priorities, but this type of method had not been useful in smaller groups. If we apply the same method when we work on values with positive content, people want to demonstrate how they like it, or how important it for them. There is no relevant implication for ranking or priorities.

Later on some questions have been repeated among students from the questionnaire of World Value Survey concerning their confidence towards different institutions. After some years of experimental work I realised, that if we ask their opinion about certain items, they would give neutral answers like "in some aspects", "somewhat less good", "neither good nor bad" etc. These answers are useful to indicate debates and discussions about the given theme, but they do not implement clear, definite resolutions. At that dimension direct ranking might help us to force deeper relations behind the order, particularly if we need the arguments behind the sequence.

Within the structure of the BA programmes of the Kindergarten and Elementary Teacher Training the Hungarian regulation prescribes special courses of 12 credits during the 3 or 4 years training. I was fortunate to be asked to elaborate a new module for it, which followed the previous European

studies traditions, supplemented by some practical individual and group work using the suggestions of our last European project (ISTEPEC, 2007). [3]
At the programmes of further education for in-service teachers, a similar course has been elaborated, but in a really concentrated way, with altogether 5-6 hours consultation. European studies course was offered for ERASMUS students as well, which give a unique opportunity to compare the attitude of the homogeny and the international student's groups.
"ISTEPEC reads: Intercultural Studies in Teacher Education to Promote European Citizenship. There are clearly three threads that are closely intertwined: Teacher Education, European Citizenship and Intercultural Studies. They all combine to create the dynamics of the programme. Teacher Education is one of the driving elements in the shaping of the future. To take up Hannah Arendt's ideas of the responsibility of adults towards younger generations, teachers (as representing one stance of adults) have their own responsibility there." Working with values directly focuses on the essential features of human being and gives chance for future teachers to be well-oriented towards their profession.
"European citizenship has legal, judiciary, social, economical and cultural colourings. The legal texts establishing European Citizenship already exist and are applicable in the European Union. However, public opinion and everyday practices throughout the Member States do not match the legal framework. Public opinion is lagging behind, but appears clearly when we ask concretely their opinion towards certain values." [4] If we have an international group, values offer unique opportunity to find common points and differences in orientations and attitudes.

3. Result of individual work

Some years ago within the European project ISTEPEC a list of European values have been collected (like peace, freedom, democracy, equity etc.). The list composed in alphabetic order was handed out to the students in the classroom or as a task for individual work at home. They had to make their own ranking according to the importance of each value. Their order – even they work in pairs, groups or individually – definitely subjective, this is why this summary concentrates the arguments given by the students to the first and the last three values of their rank. The values given by ISTEPEC project and used among students are as follows:

Avoidance of violence
Communicative attitude
Democracy
Economical thinking
Engagement
Environmental responsibility
Equity
Freedom
Intercultural communities
Linguistic and cultural diversity
Open-mindedness
Peace
Pluralism
Rational decision making
Respect
Solidarity
Supporting sustainable development
Tolerance

The 18 values were given in a rigid alphabetic order (according to the Hungarian alphabet among Hungarian students, and English in international group). The task was to create their private ranking or a ranking in group according to the importance of each value. The analysis shows the result of individual, written rankings of three different groups (N=128). The subjective character of the answers appeared clearly in the results of T-test and standard deviation (see Table 1., Table 2.).

Table 1. T-Test

One-Sample Test Test Value = 1	t	df	Sig. (2-tailed)	Mean Diff.
Avoidance of violence	15,044	120	,000	5,860
Communicative attitude	25,496	120	,000	10,545
Democracy	11,195	124	,000	4,984
Economical thinking	20,408	122	,000	8,805
Engagement	20,962	123	,000	8,863
Environmental responsibility	17,516	122	,000	7,577
Equity	28,745	121	,000	10,230
Freedom	11,970	123	,000	4,766
Intercultural communities	35,650	123	,000	12,565
Linguistic and cultural diversity	27,990	124	,000	11,920
Open-mindedness	26,913	121	,000	10,598
Peace	7,461	124	,000	2,632
Pluralism	22,529	119	,000	10,442
Rational decision making	19,224	120	,000	8,124
Respect	18,874	119	,000	8,233
Solidarity	24,859	121	,000	9,549
Supporting sustainable development	15,998	121	,000	7,557
Tolerance	20,757	120	,000	8,950

Looking at the minimum and maximum values given to the notions we can observe great variety. It is interesting, that almost all entity of the list have got at least one or two cases the first position. The absolute first place was given to "Peace" (code = 1, number of cases = 61!), the next is "Democracy" (Number of cases = 18!)… But the opposite is the same: almost every value has been ranked as the last (code=18.).
Examining the results of the three groups of students (full time trainees in Moral studies course, part time trainees in European studies course and

part time in-service teachers of further training) the differences are not really significant.

Table 2. Rankings given by the whole sample

	N	Min.	Max.	Mean	Std. Dev.
Peace	125	1	17	3,63	3,944
Freedom	124	1	17	5,77	4,434
Democracy	125	1	18	5,98	4,977
Avoidance of violence	121	1	18	6,86	4,284
Supporting sustainable development	122	1	18	8,56	5,218
Environmental responsibility	121	1	18	11,55	4,550
Rational decision making	121	1	18	9,12	4,649
Respect	120	1	18	9,23	4,779
Economic thinking	123	1	18	9,80	4,785
Engagement	124	1	18	9,86	4,708
Tolerance	121	1	18	9,95	4,743
Solidarity	122	1	18	10,55	4,243
Equity	122	2	18	11,23	3,931
Pluralism	120	1	18	11,44	5,077
Open-mindedness	122	2	18	11,60	4,350
Linguistic and cultural diversity	125	1	18	12,92	4,761
Intercultural community	124	1	18	13,56	3,925
Valid N (listwise)	110				

The first 3-4 positions and the last 3-4 positions are almost the same in each group: peace, freedom, democracy, avoidance of violence on the top, open-mindedness, pluralism, linguistic and cultural diversity, intercultural community at the end of the list. It is only the middle part, where we can recognize some inconsequential differences.

Table 3. Rankings of the subsamples

Full time – Moral	Part-time EU studies	Part time in-service
N=46	N=46	N=36
Peace	Peace	Peace
Freedom	Freedom	Democracy
Democracy	Democracy	Freedom
Avoidance of violence	Avoidance of violence	Avoidance of violence
Supporting sustainable development	Rational decision making	Supporting sustainable development
Environmental responsibility	Respect	Environmental responsibility
Respect	Environmental responsibility	Economic thinking
Engagement	Supporting sustainable development	Rational decision making
Tolerance	Tolerance	Solidarity
Rational decision making	Engagement	Respect
Economic thinking	Economic thinking	Tolerance
Equity	Solidarity	Engagement
Solidarity	Equity	Open-mindedness
Open-mindedness	Pluralism	Linguistic and cultural diversity
Pluralism	Open-mindedness	Pluralism
Linguistic and cultural diversity	Linguistic and cultural diversity	Equity
Intercultural community	Intercultural community	Intercultural community

If we see the official declarations of the European Union, we can find some essential values like peace, democracy, freedom as a principle of the documents. The most important result of the examination is to show the high level acceptance of the so called European Values.
Even though we observed large standard deviation within the ranking, the final result gives positive picture on the values defined as “most important” according to the actual opinion of students and teachers.
Observing the exceptional status of “Peace” in all three groups the question is evident: why did they feel it so important? The answer was given by the comments: according to the students opinion “Peace” is more than a simple value among the others. It is an absolute precondition because without peace any of the other values would not been existed. This circumstance indicates the opportunity to create the list without “peace” and cumulate the first and second positions of the sequence behind. On that basis we can see a more consequent ranking:

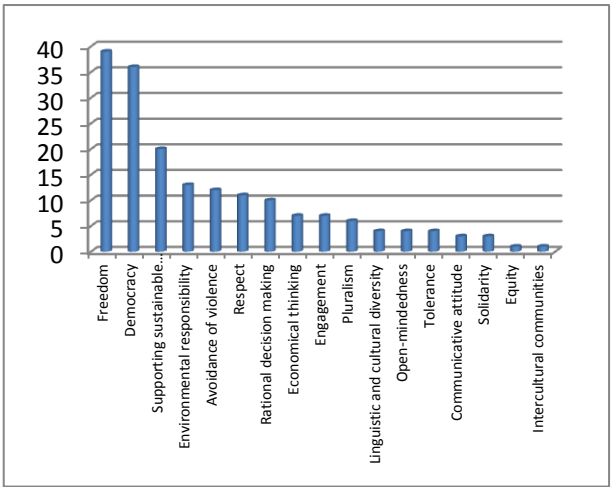

Figure 1. Ranking – missing “peace” (N=128)

4. Comments of the rankings

The first sentence of students’ reflections towards the ranking used to be an ascertainment: every element of the list is important, so it is really very complicate and difficult to make any ranking. All of us can produce the same feeling if we start to make our own ranking. This is why the comments and the arguments created by the students and in-service teachers show deeper and more exiting reflections on certain understanding and the real importance of the values.
At first let us see the comments for an exceptional ranking:

1. *The concept of rational decision-making is one of the most important features of social development... Nowadays aging of European societies is an essential problem, but a*

reasonable, sensible policy might solve the problem. Any approach without rational consideration can lead to social disaster.

2. *Sustainable development is a very important factor for all of us... An economic downturn can generate social discontent leading to the decline of the society.*
3. *I would like to add pluralism to the rational decision-making, because different ideas, views, opinions must be given to solve the problems. A good decision-maker is able to weigh the values and the corresponding decisions within the limit of rationality.*

Rational decision is not very reasonable among Hungarian people, even it is emphasised as a result of the modern societies. The interpretation of pluralism (and equity as well) raised problems for the students: missing values were more frequented, or they put it to an indifferent place. Working with groups showed evidently how important is the understanding and interpretation of each entity to find a common conceptual context of the values. Individuals tend to feel themselves to know concepts without careful analysis and understanding.
Some other interesting explanations use satisfying arguments from the end of the list:

16. *Solidarity is important because it can help people in the progress of society, but obviously not as greatly. Solidarity, equity and respect are relevant for the maintenance and the development of the society, but not essential...*
18. *The European Union is a very diverse linguistic and cultural community, which is why it is very important to preserve our culture. Therefore, do not consider that the concept of intercultural community is essential, because this kind of community, the mixture and meeting cultures may lead to their disappearance.*

The fear of uniformity and cultural assimilation was a characteristic argument against intercultural community and linguistic diversity. The same features appeared in different values studies and examination among Hungarians: closed personal attitude, low level of tolerance and trust, strongly related to traditions and authorities. (Keller, 2009)
Even though there are serious comments argue for the basic features and values of the modern, democratic societies:

1. *Democracy: throughout history it has been proven that only those societies could function effectively, which operated according to the broadest masses of the people's will. Long-term goals can only join forces to solve a particular nation or group. And assumes the right to expect the possibility of a free speech, the practice of democracy.*
2. *Freedom: a series of free decisions includes the possibility of mistakes too. Significant sense of freedom helps the development of a given society. The American-style liberal democracy was effective because the citizens feel that their life is based on individual liberties and there are wide opportunities to achieve their goals. It also strengthens the sense of freedom.*
3. *Pluralism: the successful function of multi-party system and opposition to the ruling power struggle healthy. Without effective and vigorous opposition to the ruling power, you lose all control. We know how long a car is able to run without brakes...*

Finally there is a summary of the arguments for the last positions again:

"I put open-mindedness, intercultural community and respect at the place of 16 17, 18. Not because I think they are not important, but because of the others are more important according to my scale of values. Open-mindedness and respect contain much more subjective elements such as the preceding concepts. The normal functions of a society, however, need objective facts and decisions."

5. Conclusion

The work with European values among future and in-service teachers – even the limited sample and significance – strengthened the general tendency revealed of the local and general examination: the indebt heritage of historical experiment and the influence of uncertainty during the period of political and economic transition.
"The impact of the post-communist past has at the same time been further strengthened and mediated by transition development difficulties.
As already indicated, the transition has been accompanied by considerable economic difficulties that have left sizeable social consequences, visible in diminishing GDPs in the 1990s, rising unemployment, and rising poverty and social inequalities. Because of that, the basic assumption that social development is going in the direction from survival to self-expression values should be affected. In societies where existential security is threatened, people emphasize economic and physical security, and there is not much space for values of self-expression, subjective well-being and quality of life.
Furthermore, if people emphasize economic and physical security, they feel more threatened by foreigners, ethnic diversity and cultural changes.
They usually have less trust in other people, report poor health, show intolerance towards homosexual people, support traditional gender roles and hold more authoritarian political attitudes." [5]

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COLLEGE STUDENTS' DIFFICULTIES IN DEVELOPING THEIR FOREIGN LANGUAGE COMPETENCES

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Abstract
This paper is a continuation of a college research (2012) which aimed to explore our first year students' attitude towards foreign language learning and was built on a sample of about 300 students. The purpose of the present article is to examine the reasons why college students can step forward in developing their foreign language competences only in very small number. This can be seen from the examination results documented by the College. The research instruments are questionnaires and interviews. The students' formal assessments are also examined to get a clearer picture. In the article we explore how effective students' learning strategies are, how their attitude has changed during their studies, what competences and language skills develop or stagnate and why. Current literature on adult language learning difficulties are also taken into account and special teaching programs for young adults are examined. The final conclusion of the research is that specific, graded teaching programs and motivating learning environment on the one hand, and some subjective elements such as motivation, feeling of success and usefulness on the other hand would provide better support for our students in developing their language competences.

Keywords:
competences, aims, difficulties, strategies, results

1. Introduction

In the past ten years, since a complex B2 language exam is one of the requirements of a bachelor degree, every year more and more students finish their studies and start their working career without a diploma. In some cases this situation does not mean that they cannot get a job in their profession, for example in engineering, but their salaries are lower. However, in education our former students without a language exam cannot be employed without a degree certificate, neither in kindergarten nor in elementary schools. The maximum they can get is a teaching assistant job. Another problem is that students without a language exam cannot join further education courses offered by their home institutions or other colleges or universities. The situation is about the same at colleges throughout the country. At universities most of the students have at least one language exam before they enter the higher education institution, as the extra points mean better chance for the students to get admission.

The situation can be examined from a different angle as well. In compulsory education from the age of 10 to 18 students have at least 3 lessons a week in minimum one foreign language. It means that they have about 800 lessons before the secondary school final examination. 800 lessons should be enough for a B2 level (Common European Framework) examination. Thus, in quantity we can say that compulsory education in Hungary provides the possibility for every learner to pass a B2 level examination. Money cannot be a problem either, as the advanced level final examination, which is free, equals a B2 exam (above 60 %).

However, for decades, only about 20 percent of the generation has had B2 level exams and only a few of them can speak a foreign language in 2-3 years' time. At this stage, the objective factors will be examined, which create a general background for our students foreign language achievements. Some of these problems have not been examined nationwide, so there are no exact data available, although teachers and school managements are aware of them. There are schools where foreign languages are not very important as the school environment does not require so. The majority of the students from these schools do not go to higher education, so language learning is of secondary importance. If a smaller percentage of students (the best ones and most motivated ones) still get into higher education, they do so because they have quite good school results and their collected points entitles them for admission without a language exam. This is only possible, on the one hand, at colleges or universities which train future professionals for the segments of the economy where there is a great demand for young experts like technical engineering. Other colleges, where the minimum admission level is fairly low, also accept students without language certificates, as they fulfill the minimum point requirement.

These students start their higher education studies with at least eight years' of foreign language instruction and usually with 50-60 % results at

intermediate level final examination (which is A2/B1 level of language knowledge according to the Common European Framework). Most of them could not pass the B1 level examination (basic level) which usually needs 300-400 hours of language instruction.

If this is the starting point, colleges should provide the necessary number of lessons and the problem is settled. However, there are several difficulties for both college managements and the students. The colleges do not have extra money for supporting students who arrive without language exams. In the managements people often feel that this requirement is only the question of motivation and it is the students' task to learn. The students who have many problems with other subjects (mathematics, physics, etc.) do not seem to be aware of the situation. They are not motivated and they lack the knowledge and learning strategies which could support them in this field. Thus, for engineers, kindergarten teachers or primary school teachers, who feel that they will never use any foreign language in their own profession, the greatest obstacle in the way of getting a degree is the language exam as a degree requirement.

At this point it is important to state that the author as a language teacher with some international experience thinks that foreign language competences are extremely important for everyone. No matter what our profession is, we all need to develop, not to mention the fact that speaking foreign languages open the world.

In this article we focus on students' problems and do not examine the problems of the education system or the level of teaching.

2. Exploring students' beliefs on their own problems in language learning

Language teachers at the college have always experienced that there are serious problems and it is extremely difficult to help students in language learning. Until the B2 certificate became compulsory, it was only a professional problem for teachers. When the language requirements became stricter, the problem became more and more urgent for the colleges, too.

In 2010 while Mercedes Benz Manufacturing started its settling down in Kecskemét, the factory organized a survey to explore our students' professional skills. The results were quite good. They found that except language competences our students proved to be good, in some fields such as creativity exceptionally good. Students had the worst results in language competences.

In 2012 we did a questionnaire survey involving 567 students. We were interested in their' beliefs on language learning and what difficulties they recognize. Some of the results had been published in the same year [1].

To explore our present problem one conclusion of the data examination is important. The students arrive at Kecskemét College with A2 rather than B1 or B2 level of foreign language [2].They have this result after learning the language in compulsory education for at least 8 years. The questionnaire also focused on the students' opinion on their own language problems. The results show that they find certain skills, like listening comprehension, certain conceptual parts like tenses and finally some grammatical points difficult. The answers can help us develop a better course, but does not answer the question of students' final failure – as a great number of them do not actually get their degrees, because they cannot produce the certificate proving their B2 level of the foreign language.

Further data collection tried to clarify when and how their failure started. This time some interviews tried to explore the history of each student's language learning. 20 students first filled in a questionnaire on their language learning history, then, deep interviews followed. The students' answers fall into three categories: those who are lost from the beginning, the ones who were enthusiastic first and gradually found language learning more and more difficult, and finally those who could not reach the last step and gave up at the end.

The first group arrived in the secondary school with serious fallbacks, could not catch up in secondary education and gave up language learning as soon as they could. They blame themselves, their teachers and the whole system. They think it is only possible to learn a foreign language if they can spend a long period of time in a target language community.

The second group enjoyed language learning in the primary school, especially in lower primary. Language learning was a playful activity for them, they were motivated and enthusiastic. However, when the playful elements started to disappear and only vocabulary tests and grammar-translation seemed to be the most important part of language lessons, they lost their enthusiasm, their results became worse and worse, and by the end of the secondary school they also gave up.

The final group successfully managed to pass over the first obstacles and worked hard (because they wanted to prove for themselves or because of parents' impulses). They had relatively good results in languages, but had tried B2 level exams many times without success. They are in despair as they had spent a lot of time, energy and money on getting the necessary certificate, but without success. They blame their teachers, the language exam itself, they even suspect that the whole system is corrupt. By the end of the interview the girls usually burst into tears, and all of them seemed very pessimistic.

Some students who finally passed the intermediate language exams were also interviewed. We wanted to know the same: where and why in the language learning history they had unsuccessful periods or failures. Very few of them thought that although it was hard work, it went with flying colors. Most of them think preparation for the language exam was a nightmare, they complain about difficulties in finding a good teacher, a good book and they would have needed more practical pieces of advice.
Each interview had a part in which the questions focused on how they would change the system and what are the things they would do differently. Nearly all of them think that language exams are not necessary; they have never been active language users and will never be. Former students have had little chance to find a job in which they can use their language competences. I had only three interviewees whose school took part in European Union Projects and they not only used their English, but they proved to be very important new colleagues in the school. However, only one of them had the benefit to get a final contract as a result of her participation in the international project.
Most of the others think that language learning is not necessary for teachers in kindergartens, lower primary schools or in industry. Only those who want to go abroad to work think that their language learning efforts might turn out to be beneficial. The majority of the former student interviewees forgot most of their foreign language skills. I hope this will change with the job opportunities Mercedes Benz manufacturing can offer in Kecskemét.

3. What we have tried to be more effective…

It seems to be quite important to achieve some relevant changes, especially in supporting students to be able to pass a language exam successfully and finish their studies with a degree as soon as possible. Several facts can be blamed for the present situation. We feel that in primary and secondary school language teaching there are a great many tasks ahead, and in our teacher training programs we have to prepare future language teachers to face them, however, in this paper we are going to deal mostly with the ones in our scope. This is why our former research on what actually students' needs are will be important for the present examination. Firstly, as the research results revealed, students have no motivation, know very little about how to learn languages, it is not clear for them how much work it is. We recognized this some years ago, and tried to solve the problems. We gave lectures on the aims and possibilities and difficulties of language learning at the college in the foxes' camps for years. We organized games and quizzes in foreign languages in the same camps, registration weeks had seminars and lectures to develop language learning skills. Hungarian colleagues were encouraged to give relevant English/German expressions in their Hungarian lectures. Foreign guest professors gave lectures on professional topics for students. We launched language courses for students and refunded the money for those who passed the language exam. We also tried to encourage students to apply for ERASMUS studies abroad. We wrote articles in college papers (Forum, Titeknek) to help students realize the seriousness of the task. We publicized students who had passed the exam (reports and interviews in college paper).
It seemed that teaching should also be adapted to the learning needs of college students. We tested the knowledge of incoming students, placement tests helped us to organize groups which could develop students' existing knowledge (not to start language learning again as in compulsory education). This is not very easy because of the great number of students and time-table difficulties.
Modern ICT was also included into the curriculum, we had mock exams and test banks students could turn to if they needed extra tasks. We have tried (at the Teacher Training Faculty) a computer assisted language program for half a year. English speaking films were shown and professional problems were discussed in the target language. We prepared an application for the renewal of language learning, although it was not successful. Different college boards (the Senate, Rector's Board, faculty councils, etc.) dealt with the problem and had decisions on changes.
In the past 10 years different language teaching courses had been written, accredited and implemented into the curriculum and finally launched. Especially at GAMF, the engineering faculty, students have the chance to take part in free language learning throughout their studies (general language development, exam preparation, professional language courses, etc.), but they have never been exploited.
However, the results of all these efforts are appalling. More students get their diplomas nowadays than 5 years ago, but this might be the result of the higher number of students coming with language exams, unfortunately.

4. Conclusion

The solution to the problem is not in the answers of the interviewees, but it is behind their answers. The students blame mostly the school system and the language exams. They sometimes complain about the heterogeneous groups, the circumstances of teaching at college, etc.
It is obvious that better results cannot be expected from increasing the number of language lessons. In the curriculum the number of foreign language

lessons is already high, and it causes tense in the training. The effectiveness of teaching can be increased by better teachers/teaching (the complaints are usually not about the lessons and the teachers) or better learners (it is not a choice for us; we have to teach the students of the college).

The content of the courses can be changed, though. We should train students to be better language learners and provide them with better language learning skills. A good language learner [3] is motivated, has got aims and is willing to try what he/she has learned. A good language learner has confidence and is not afraid of making mistakes. They have to believe that without using the language they are not able to learn the language. It should be past tense that students need to be spoon-fed and their learning is limited to the exam period, especially in language learning. We have to make them be aware of the fact that language learning is a long process, which needs active participation.

Vocabulary learning needs to be renewed as well. The basic words and some academic vocabulary (about 2,500 words) needs to be taught in foreign language classes, but after that, only vocabulary learning strategies *can* help students develop their own vocabulary [4]. In this professional vocabulary development, after learning how to learn new words, subject teachers (college tutors) could help more than language teachers.

It is true that people cannot change their learning styles easily, and we stick to how we learned when we started our school career. However, we need to learn that new requirements require new learning strategies. The present language learning difficulties root in learning skills. Thus, the best thing we can do is to support our learners in becoming better language learners, or to teach them how to learn languages.

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METACOGNITIVE STRATEGIES IN EFL VOCABULARY LEARNING

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Abstract

Hungarian primary school learners' vocabulary learning is constituted of a variety of components, such as motivation, vocabulary learning strategies, metacognitive strategies, self-motivation, and self-regulating capacity. Among these components metacognitive strategies play a significant role in making vocabulary learning successful by being aware of the importance of utilising practice opportunities, knowing about the language, and being able to define the individual's actual stage in the process. In this paper, I will discuss evaluating and monitoring strategies and based on children's self-report outline what they think about the level of their English knowledge, what they do to keep that level, and how they perceive the constituents of knowing a word. Based on the results I will illustrate the importance of metacognition in learning vocabulary in a foreign language.

Keywords:

metacognition, learning strategies, vocabulary learning, EFL, self-regulation

1. Introduction

There is no doubt that metacognition plays a significant role in learning English as a foreign language (EFL). Metacognitive thinking and understanding, and metacognitive strategies are all seem to be essential to succeed in language learning. Since vocabulary learning is one of the main aspects of language learning, metacognition is crucial in this field as well. In this paper, young learners' (YLs) metacognitive strategies used for learning English are in the centre. The research focuses on strategies that were elicited in a large-scale study in the framework of self-regulated vocabulary learning.

Metacognitive strategies are often discussed as one component of vocabulary learning besides cognitive, memory, and social strategies. However, in the large-scale research which provided framework for the investigation of YLs' vocabulary learning strategies, in order to underlie its importance, metacognition formulated an individual category. Therefore, data management makes it possible to analyse and discuss metacognition individually in this paper as well. In the following, after the concept of metacognition has been outlined, I describe the research methodology, i.e. participants, settings, and procedures, present and discuss the results, and, finally, draw some conclusions.

2. Metacognition

The development of metacognition is attached to the acquisition of the theory of mind [9] which can appear at the age of 3–5. As a cognitive ability it highly determines the development of metamemory and metacognitive knowledge, and its development is life-long [4]. Researchers seem to agree that children, irrespective of their proficiency level, are capable of describing their learning and thinking processes in depth, indicating that "metacognitive awareness begins at quite an early stage" [2, p. 31]. This fact ensures the success of research among YLs because it implies that they are able to report what they are doing when learning a foreign language.

Researchers have investigated metacognition and its constituents along two lines. Cognitive psychology has studied the determinants and consequences of monitoring knowledge [3], while developmental psychology has investigated the role of metacognitive processes in children's memory functioning [7]. From the developmental perspective the examination of metacognition has been expanded to the field of education. Flavell [3] states that metacognition consists of metacognitive knowledge and metacognitive experiences or regulation.

Metacognitive knowledge is used to control knowledge of cognitive processes and includes knowledge about variables that interact with each other. The conditions of the learning process and the learner's individual beliefs contribute to metacognitive knowledge in a conscious or unconscious way. Metacognitive knowledge is "a prerequisite for the self-regulation of language learning: it informs planning decisions taken at the outset of learning and the monitoring processes that regulate the completion of a learning task…" [10, p. 528]. If knowledge is actively used in a strategic

manner to ensure meeting a certain goal we speak about 'metacognitive knowledge'. Knowledge about strategies refers to the awareness in the use of strategies while completing a task. Livingston [5] extends the scope of metacognitive strategies and adds knowledge about cognitive strategies, and knowledge that enables the learner to decide on the conditions of applying strategies properly.

Metacognitive experiences refer to conscious cognitive and affective experiences, which involve the use of metacognitive strategies [3] (Flavell, 1979). In the field of learning strategies there is a growing importance of metacognition. It appears in leading learning taxonomies [6] among the main strategy types that learners employ for learning. Anderson [1] divided the metacognitive learning process into five primary components: (1) preparing and planning for learning, (2) selecting and using learning strategies, (3) monitoring strategy use, (4) orchestrating various strategies, and (5) evaluating strategy use and learning (2002, p. 1). Out of the primary components of metacognitive learning, in this paper, I concentrate on evaluating and monitoring strategies, which will be discussed in the special field of vocabulary learning.

Since the components of metacognition are closely related to self-regulated language learning, metacognition seems to override the vague boundaries of learning strategies [8] and can be handled as an individual entity chiefly assisting the process of language learning. Learners who are metacognitively aware can have some knowledge about when and how to use particular strategies for learning or for problem solving. Therefore, YLs' metacognitive strategic thinking is examined as a single category of self-regulated vocabulary learning.

3. Methodology

Hungarian primary school children (N=331) from grades 3 to 8[4] took part in the large-scale research from where the data of metacognition is taken. Participation was voluntary throughout the research. All of the participants were learning English as a foreign language in a school setting. The youngest learners whose vocabulary learning was investigated were third graders, because they started learning a foreign language in this class, and because it was supposed that they had developed a certain level of metacognitive thinking and understanding [2] that allowed them to intelligently verbalize their learning process. Throughout the research, the participants were informed about the primary purpose of data collecting, and anonymity was guaranteed.

The whole research was conducted in six elementary schools in Kecskemét, Hungary. Five of them were state schools situated in residential areas, and one was a religious primary school situated in the middle of the town centre. Children in all these schools were learning English as a foreign language and had different number of classes a week depending on whether they were specialised in learning English or not. Those who were specialised had 4 or 5 lessons, and who were not had 2 or 3 lessons a week. Since my intention was to include a wide range of children in the investigation, the differences in the schools, in the number of lessons, and the different level of specialisation supported the diversity of data and helped to create a comprehensive picture of young learners' self-regulated vocabulary learning.

The data analysed in this paper is based on the data of the large-scale research, which investigated the self-regulated and strategic vocabulary learning of YLs. Since metacognition was investigated as a primary component of self-regulated vocabulary learning and represented one category, it can be analysed independently from the other components. The instrument used for the investigation was a four-point Likert-type rating scale which was developed in the large-scale research, and in which 1 meant 'I don't agree', 2 'I partly agree', 3 'I agree', and 4 meant 'I strongly agree'. Offering a four-point scale was supposed to result in more refined answers than using three options, since participants were not offered to take a middle position, but 'forced' to choose between the options.

The strategies of metacognition that were elicited in the large-scale research relying on YLs' self-report are presented in Table 1. Three strategies belong to self-evaluation, five to knowing about language and two to self-monitoring.

First, I present inferential statistical results to provide a general view and then the results of descriptive statistics will be illustrated for specific information. The correlation matrix (Table 2, Appendix 1) shows that almost all the items of metacognitive strategies significantly correlate with one another meaning that there is a strong connection between the uses of these strategies in young learners' self-report. The only exception is strategy 1 in the case of which the correlation is not significant with a lot of other strategies.

[4] Children in Hungary start primary school studies at the age of 6 or 7, thus in the third grade they are 8 or 9 years old, and in grade 8 (when they finish primary school studies) they are around 14 or 15.

Table 1. Metacognitive strategies in YLs' self-report

Metacognition Evaluation, Self-evaluation
1. I can *express** myself in English.
2. I can make myself *understood* in English.
10. I *have to learn* a lot of words to succeed in English.
Metacognition Monitoring, Knowing about language
3. I know a word if I can *use it in a sentence*.
4. I know a word if I can *say it correctly*.
5. I know a word if I can *write it correctly*.
6. I know a word if I can always *recall* it when I have to use it.
7. I know a word if I *know its meaning*.
Metacognition Monitoring, Self-monitoring
8. I often *review* the English words in order not to forget them.
9. I am able to *form* more and more *sentences*, because know more and more words.

* The keywords of each strategy are put in italics and in the following noted under the tables in which they occur in order to make interpreting the results easier.

Moreover, there is a strong negative correlation between strategies 1 and 10, which suggests that those children who think they can express themselves in English do not think they have to learn a lot of words to succeed. The correlation is also negative between items 2 and 10, which can mean that those who can make themselves understood in English do not think that they should learn a lot of words to be able to do it. The negative correlations between these items imply that the YLs who took part in the investigation think if they reach a certain level of vocabulary that makes it possible to succeed they do not have to learn a lot more words, or they can succeed with a relatively low level of vocabulary.

The correlations with the exception of strategy 4 are not significant between strategy 1 and the strategies of 'finding out about language learning' (strategies 5, 6, and 7) implying that those who think they can express themselves in the target language do not consider most of the aspects of knowing a word important. It implies that YLs who think they are be able to express themselves are aware that they have to say words correctly, but they do not think that using a word in a sentence or knowing how to write it, and recall it whenever it is needed or knowing its meaning are essential for being able to express themselves. In the case of strategy 2 I found the same only between strategies 3 and 5 implying that YLs think they can make themselves understood without being able to use words in a sentence or writing them correctly. The correlations let us conclude that the perspective of vocabulary learning should change, since children's opinion on the importance of knowing a particular aspect of a word may rely on the false belief that knowing word meaning is enough for being able to express themselves or make themselves understood. The reason for this false view may come from the teaching and testing techniques, which facilitate word meaning without concentrating on contextual issues.

All in all, the significant correlations between these items show the importance of metacognition in learning foreign language vocabulary. Based on the database, the reliability coefficient of metacognitive strategies was relatively high (Cronbach's Alpha 0.70) and the item-total statistics proved that the investigated items reliably constitute the metacognitive strategy use of YLs. This finding means that the learners who took part in the research recalled metacognitive strategies that contribute jointly to vocabulary learning.

Factor analysis reinforces the categories of metacognition. The KMO index of sampling adequacy was 0.74 which indicates that the data factors well. Three components were extracted in the analysis (Table 3), which clearly represent the main types of metacognitive strategies YLs reported to use in the sample. These are the strategies of self-evaluation, self-monitoring, and knowing about language. The strategies that chiefly represent each factor are in bold.

Table 3. Factor analysis: Component matrix

	Component		
	1	**2**	**3**
1	0.37	**0.76**	-0.05
2	0.41	**0.73**	0.00
3	**0.55**	-0.31	-0.13
4	**0.56**	-0.10	-0.56
5	**0.61**	-0.23	-0.44
6	**0.59**	-0.13	0.11
7	**0.52**	-0.10	0.22
8	0.55	-0.03	**0.12**
9	0.56	0.27	**0.42**
10	0.40	**-0.52**	0.47

Extraction Method: Principal Component Analysis.
3 components extracted.

In factor 1 the items from 3 to 7 represent the coherence of the strategies of knowing about language. The components belonging to the strategy of self-evaluation formulate factor 2. Whereas items 1 and 2 strongly represent the strategy of self-evaluation, item 10 negatively signifies this strategy group. This finding confirms the result of correlation analysis in which strategy 10 had a negative correlation with strategies 1 and 2. In factor 3 there are items 8 and 9 with relatively high values which indicate the strategies of self-monitoring. The finding that the three factors clearly represent the main strategies of metacognition supports the structure of YLs' metacognitive strategies.

The tables below (Tables 4, 5, 6 and 7) show the descriptive statistics of metacognitive strategies.

Table 4 shows the means and standard deviation of the strategy items.

Table 4. Means of metacognitive strategies

	1	2	3	4	5	6	7	8	9	10	Total
Mean	**2.87**	2.93	2.79	2.88	2.90	3.19	**3.49**	2.98	3.38	3.38	**3.07**
Std. Dev.	**0.60**	0.64	0.99	0.91	0.89	0.85	0.65	0.85	0.68	0.73	**0.41**

N=331
1.express, 2 make oneself understood, 3 use in sentences, 4 say correctly, 5 write correctly, 6 recall, 7 know meaning, 8 review, 9 form sentences, 10 have to learn a lot

The total mean value (M=3.07) indicates that YLs normally agreed on using these strategies of metacognition for learning vocabulary. The lowest mean is in the case of strategy 1 (M=2.87) '*I can express myself in English.*', and the highest is in strategy 7 (M=3.49) '*I know a word if I know its meaning*'. It means that most of the children who took part in the investigation agreed that they could not express themselves in English. This result is supported by the lowest value of standard deviation belonging to strategy 1. However, most of the children agreed that they know a word if they know its meaning. This finding implies that YLs think that the most important aspect of word knowledge is meaning, and they also agreed that the ability of recalling meaning (strategy 6, M=3.19) is important. Children also agreed on strategies 9 and 10 (M=3.38), i.e. that they are able to form more and more sentences, because they know more and more words, and that they have to learn a lot of words to succeed in English.

Table 5 (Appendix 2) presents the age-related differences in YLs' answers of using the strategies of metacognition. The highest and lowest means are in boldface type in the table in order to illustrate the differences in strategy use between the classes. Children in classes 3 and 5 gave the lowest scores to strategy 1 implying that they cannot really express themselves in English. Fourth graders, however, gave a higher score to this strategy. They gave the lowest score to strategy 5 (M=2.61) '*I know a word if I can write it correctly*', which means that they do not agree with this statement. Forth and fifth graders gave the highest scores to strategy 9 (M=3.57, M=3.53) '*I am able to form more and more sentences, because I know more and more words*', which implies that they are aware of the importance of vocabulary knowledge both at word and sentence level. YLs in grades 6 and 7 gave the lowest scores to strategy 4 (M=2.56, M=2.69) '*I know a word if I can say it correctly*' and the highest to strategy 7 (M=3.52) '*I know a word if I know its meaning*' implying that children in these classes think that word meaning is more important than correct pronunciation. Strategy 7 scored the highest by children in classes 8 (M=3.35), as well. Although eighths graders scored the lowest in strategy 3 (M=2.46) '*I know a word if I can use it in a sentence*' implying that they do not think that they need to know how to use words in a sentence, they agreed with the statement '*I am able to form more and more sentences, because I know more and more words*' (strategy 9, M=3.09). All in all, considering the age groups, strategies 7 and 9 got the highest scores, which suggests that meaning is the most important aspect of word knowledge among YLs in each class and that YLs in each class are aware that knowing more and more words can result in being able to form more sentences.

Table 6 (Appendix 3) shows YLs' metacognitive strategy use in the framework of their marks in English. Based on the marks, strategy 3 (M=2.80) '*I know a word if I can use it in a sentence*' got the lowest and strategy 7 (M=3.47) '*I know a word if I know its meaning*' the highest scores. Children whose marks were 2 seemed not to agree on strategy 8 (M=2.19) '*I often review the English words in order not to forget them*', but agreed on strategy 10 (M=3.31) '*I have to learn a lot of words to succeed in English'*. This finding implies that although the learners with the worst mark are aware that they have to learn a lot of words to succeed, they do not review the vocabulary. The reason for this can either be their low level of motivation or the inadequate testing practices, which reinforce immediate word knowledge without taking vocabulary retention as a focal point.

Those learners whose mark was 5 gave relatively high scores to each strategy. Interestingly, strategy 4 (M=2.93) '*I know a word if I can say it correctly*' was scored the lowest by learners with mark 5 in English which finding reinforces that learners do not think that correct pronunciation is to much important. The reason for this, as I have mentioned before, can be the lack of oral communication in the English lesson, and inadequate testing practices which besides concentrating on meaning facilitate orthographical knowledge of words. Strategy 9 '*I am able to form more and more sentences, because I know more and more words*' got the highest scores (M=3.61) from learners with mark 5, which can be an indicative of their vocabulary knowledge and their motivation.

Another important signifier of metacognitive strategy use is the liking of English. YLs who took part in the investigation were asked to score their liking of English on a scale where 1 meant 'I hate it', 2 'I don't like it', 3 'so-so', 4 'I like it', and 5 'I like it very much'. Table 7 (Appendix 4) shows the results of metacognitive strategy use relating to YLs' liking of English. Learners who hate English scored the strategies of metacognition very low. Strategy 8 '*I often review the English words in order not to forget them*' got the lowest score (M=1.86) among all. This finding resembles the results of children with mark 2. It seems that those who hate English or get bad

marks do not review words. Strategies 9 '*I am able to form more and more sentences, because I know more and more words*' and 10 '*I have to learn a lot of words to succeed in English*' got quite high scores (M=3.29) from the children who hate English. These results imply that the children are aware that they have to learn more to be able to form sentences and, thus, to communicate. The high values of standard deviation among those who hate English mean that the opinion of this group of children is very diverse.

It is interesting that children who like English very much also gave strategy 9 (M=3.74) the highest scores, which can be the indication of their success and not only their expectation. Strategy 7 '*I know a word if I know its meaning*' got the highest scores among most of the children who do not like English (M=3.33), quite like it (M=3.50), or like it (M=3.45), which can also be a sign of meaning-centeredness of vocabulary learning. Strategy 3 '*I know a word if I can use it in a sentence*' is worth mentioning in respect of liking English. This strategy got the lowest scores among those who do not like English (M=2.40) and those who like it (M=2.69), which means that the children irrespective of their liking of English may not think that being able to use words in a sentence is an important aspect of vocabulary knowledge. This finding may also be the outcome of traditional teaching and testing practices which rely on word-level meaning and do not care for contextual communication.

4. Conclusions

Based on the findings a number of serious issues have been raised. First of all, YLs are aware of their language learning, and their self-reflective thinking on metacognitive strategies reflects teaching and learning practices. One of the most important issues is that YLs need to learn more to be able to express themselves and communicate. Although knowing word meaning is a principal aspect of word knowledge, it is not the only one. Besides knowing what a particular word mean learners should know about the orthographical, phonetic, phonological, morphological, syntactical, and pragmatic features of vocabulary to be able to use words creatively in written and oral communication.

The ability to recall words should be improved in order to fulfil the needs of satisfactory communication. This ability can develop by reviewing words and using them in evocative situations. The class differences in metacognitive strategies pointed at the fact that the participants thought that meaning is more important than correct pronunciation. Although meaning-centred education is welcome in teaching English as a foreign language, this finding draws attention to the issue of testing practices. The traditional methods of writing word tests require knowing word meaning and orthography, but do not facilitate real life-like communication, which seems to be lost in foreign language education. English lessons do not seem to provide enough opportunities for oral and written communication, and do not facilitate reviewing vocabulary in a creative way.

YLs' report on metacognitive strategies reflecting their marks and linking English indicates that learners should be motivated to learn and review vocabulary. It is a serious issue that those who get bad marks or do not like English seem not to review words. Besides motivating these learners, alternative methods for vocabulary testing should be introduced instead of the traditional method of writing word tests based on listwise memorising. Viable methods that facilitate real life-like communication, which should be the outmost goal of language learning and language teaching, should rely on contextual options, such as comprehensive memorisation, associated repetition, and sensible revision.

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Appendix

Appendix 1. *Table 2. Inter-item correlation matrix of metacognitive strategies*

	1	2	3	4	5	6	7	8	9
2	0.56**								
3	0.00	0.03							
4	0.12*	0.12*	0.28**						
5	0.08	0.08	0.31**	0.40**					
6	0.10	0.18**	0.30**	0.20**	0.29**				
7	0.09	0.12*	0.14**	0.18**	0.27**	0.23**			
8	0.13*	0.12*	0.21**	0.23**	0.25**	0.17**	0.20**		
9	0.29**	0.30**	0.20**	0.15**	0.12*	0.21**	0.21**	0.29**	
10	-0.14**	-0.10	0.24**	0.11*	0.18**	0.27**	0.23**	0.19**	0.16**

* Correlation is significant at the 0.05 level
** Correlation is significant at the 0.01 level
1.express, 2 make oneself understood, 3 use in sentences, 4 say correctly,
5 write correctly, 6 recall, 7 know meaning, 8 review, 9 form sentences, 10 have to learn a lot

Appendix 2. *Table 5. Metacognitive strategy use in the classes*

Class		1	2	3	4	5	6	7	8	9	10
	Mean	**2.91**	3.09	3.11	3.64	3.42	3.51	**3.80**	3.22	3.60	3.60
	N	45	45	45	45	45	45	45	45	45	45
3	Std. Dev.	0.70	0.66	1.04	0.67	0.91	0.69	0.40	0.82	0.53	0.65
	Max.	4	4	4	4	4	4	4	4	4	4
	Min.	1	2	1	1	1	1	3	1	2	1
	Mean	3.25	3.29	2.89	3.00	**2.61**	3.36	3.36	3.46	**3.57**	3.29
	N	28	28	28	28	28	28	28	28	28	28
4	Std. Dev.	0.51	0.46	1.13	1.08	1.03	0.62	0.78	0.63	0.69	0.65
	Max.	4	4	4	4	4	4	4	4	4	4
	Min.	2	3	1	1	1	2	1	2	2	2
	Mean	**2.83**	2.92	2.92	3.03	2.95	3.22	3.40	3.05	**3.53**	3.50
	N	60	60	60	60	60	60	60	60	60	60
5	Std. Dev.	0.64	0.61	0.97	0.82	0.83	0.95	0.74	0.79	0.59	0.67
	Max.	4	4	4	4	4	4	4	4	4	4
	Min.	1	1	1	1	1	1	1	1	2	1
	Mean	2.70	2.82	2.70	**2.56**	2.75	2.97	**3.52**	3.07	3.25	3.30
	N	71	71	71	71	71	71	71	71	71	71
6	Std. Dev.	0.57	0.68	0.96	0.87	0.84	0.95	0.60	0.83	0.64	0.74
	Max.	4	4	4	4	4	4	4	4	4	4
	Min.	2	1	1	1	1	1	2	1	1	1
	Mean	2.90	2.91	2.88	**2.69**	3.00	3.34	**3.52**	2.95	3.47	3.41
	N	58	58	58	58	58	58	58	58	58	58
7	Std. Dev.	0.55	0.62	0.91	0.84	0.77	0.76	0.56	0.78	0.68	0.77
	Max.	4	4	4	4	4	4	4	4	4	4
	Min.	1	1	1	1	1	1	2	1	1	1
	Mean	2.87	2.84	**2.46**	2.67	2.70	2.99	**3.35**	2.49	3.09	3.25
	N	69	69	69	69	69	69	69	69	69	69
8	Std. Dev.	0.54	0.65	0.93	0.86	0.89	0.83	0.72	0.90	0.78	0.77
	Max.	4	4	4	4	4	4	4	4	4	4
	Min.	2	1	1	1	1	1	1	1	1	1

1.express, 2 make oneself understood, 3 use in sentences, 4 say correctly,
5 write correctly, 6 recall, 7 know meaning, 8 review, 9 form sentences, 10 have to learn a lot

Appendix 1. *Table 6. Metacognitive strategy use and YLs' marks in EFL*

Mark		1	2	3	4	5	6	7	8	9	10
	Mean	2.31	2.50	2.44	2.37	2.69	2.94	3.13	**2.19**	2.69	**3.31**
	N	16	16	16	16	16	16	16	16	16	16
2	Std. Dev.	0.47	0.73	0.89	1.08	0.87	0.68	0.50	0.91	0.87	0.79
	Max.	3	4	4	4	4	4	4	4	4	4
	Min.	2	1	1	1	1	2	2	1	1	2
	Mean	**2.72**	**2.75**	2.78	2.83	2.92	3.08	**3.44**	3.08	3.19	3.39
	N	36	36	36	36	36	36	36	36	36	36
3	Std. Dev.	0.56	0.73	1.07	0.94	0.90	0.93	0.84	0.84	0.66	0.64
	Max.	4	4	4	4	4	4	4	4	4	4
	Min.	2	1	1	1	1	1	1	1	1	2
	Mean	2.84	2.83	**2.74**	2.78	2.81	3.16	**3.46**	2.99	3.29	3.44
	N	140	140	140	140	140	140	140	140	140	140
4	Std. Dev.	0.57	0.56	0.94	0.91	0.89	0.87	0.68	0.84	0.71	0.72
	Max.	4	4	4	4	4	4	4	4	4	4
	Min.	1	1	1	1	1	1	1	1	1	1
	Mean	3.08	3.21	2.94	**2.93**	2.97	3.25	3.53	3.01	**3.61**	3.26
	N	111	111	111	111	111	111	111	111	111	111
5	Std. Dev.	0.55	0.63	1.01	0.85	0.84	0.84	0.60	0.81	0.55	0.78
	Max.	4	4	4	4	4	4	4	4	4	4
	Min.	2	1	1	1	1	1	1	1	2	1
	Mean	2.88	2.94	**2.80**	2.82	2.87	3.17	**3.47**	2.97	3.37	3.36
	N	303	303	303	303	303	303	303	303	303	303
Total	Std. Dev.	0.59	0.65	0.98	0.90	0.87	0.86	0.67	0.85	0.70	0.74
	Max.	4	4	4	4	4	4	4	4	4	4
	Min.	1	1	1	1	1	1	1	1	1	1

1.express, 2 make oneself understood, 3 use in sentences, 4 say correctly,
5 write correctly, 6 recall, 7 know meaning, 8 review, 9 form sentences, 10 have to learn a lot

Appendix 1. *Table 7. Metacognitive strategy use and YLs' liking of English*

Liking		1	2	3	4	5	6	7	8	9	10
	Mean	2.00	2.43	2.71	2.00	2.00	2.71	3.00	**1.86**	**3.29**	**3.29**
	N	7	7	7	7	7	7	7	7	7	7
1	Std. Dev.	0.81	0.78	1.25	1.29	1.41	1.11	0.81	1.21	0.75	0.95
	Max.	3	3	4	4	4	4	4	4	4	4
	Min.	1	1	1	1	1	1	2	1	2	2
	Mean	2.33	2.80	**2.40**	2.67	2.87	2.80	**3.33**	2.27	2.53	3.27
	N	15	15	15	15	15	15	15	15	15	15
2	Std. Dev.	0.48	0.56	0.82	0.90	0.74	0.86	0.48	0.59	0.83	0.79
	Max.	3	4	4	4	4	4	4	3	4	4
	Min.	2	2	1	1	2	1	3	1	1	2
	Mean	2.71	**2.67**	2.77	2.79	2.85	3.07	**3.50**	2.76	3.10	3.44
	N	82	82	82	82	82	82	82	82	82	82
3	Std. Dev.	0.61	0.58	0.90	0.96	0.86	0.90	0.57	0.91	0.71	0.66
	Max.	4	4	4	4	4	4	4	4	4	4
	Mini.	1	1	1	1	1	1	2	1	1	2
	Mean	2.86	2.90	**2.69**	2.88	2.85	3.24	**3.45**	3.05	3.40	3.35
	N	131	131	131	131	131	131	131	131	131	131
4	Std. Dev.	0.50	0.64	0.97	0.84	0.84	0.79	0.70	0.83	0.61	0.70
	Max.	4	4	4	4	4	4	4	4	4	4
	Min.	2	1	1	1	1	1	1	1	2	1
	Mean	3.17	3.26	**3.03**	3.04	3.07	3.32	3.58	3.27	**3.74**	3.41
	N	96	96	96	96	96	96	96	96	96	96
5	Std. Dev.	0.53	0.56	1.06	0.91	0.93	0.86	0.66	0.67	0.48	0.80
	Max.	4	4	4	4	4	4	4	4	4	4
	Min.	2	2	1	1	1	1	1	1	2	1

Liking: 1. I hate it, 2. I don't like it, 3. so-so, 4. I like it, 5. I like it very much
1.express, 2 make oneself understood, 3 use in sentences, 4 say correctly,
5 write correctly, 6 recall, 7 know meaning, 8 review, 9 form sentences, 10 have to learn a lot

METACOGNITIVE METHODS OF WRITING DEVELOPMENT

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Abstract
The use of metacognitive thinking strategies received increased attention during the last decades, especially in educational settings. There is research evidence regarding the possibility of stimulating metacognitive thinking strategies during reading, resulting in increased reading efficiency.
We investigated the possibility to use writing strategies which stimulates the use of metacognitive strategies of readers. After identifying several basic metacognitive processes in reading which can be stimulated by specific writing strategies, we have reformulated several textbook-lessons in order to stimulate the use of these strategies by readers. Results show a better understanding of reformulated text by children in the experimental group as compared to children who have read the original text.
A development program was elaborated and implemented by 5 elementary school teachers during an 8-week period in order to teach children the writing strategies. Comparing pre- and posttest results of experimental and control group children shows evidence for the possibility of teaching metacognitively aware writing strategies for 4th grade children.

Keywords:
Writing instruction, reading comprehension, metacognition

1. Introduction

Efficient, persuasive writing is fundamental for succeeding in school and after school career. In educational settings students demonstrate their knowledge predominantly through writing. More important, writing is an important tool for remembering and organizing what we learn.
According to cognitive models, writing can be defined as a problem-solving process [1]. Skilled writers often “problematize” a writing task, using a knowledge transforming strategy, as defined by Bereiter and Scardamalia [2]
The sophisticated problem-solving process of writing is evidenced by think-aloud protocols of expert writers, who elaborates different content and rhetorical goals when writing. Flower and Hayes [3] points out that writing is a goal-directed process. In the act of composing, writers create a hierarchical network of goals and these in turn guide the writing process. Hayes & Flower identified three cognitive processes in writing. When planning, the writer recalls or finds relevant information, organize it according to its goals, and sets goals for communicating with the audience. The translating process includes text-producing and in accordance with the plan. Expert writers also review the text for detecting and correcting errors. Flower and Hayes’ cognitive process of writing is still considered one of the seminal pieces of research in the field of writing today.
Academic writing instruction focus on expository and argumentative writing; although other writing modes, like narrative, descriptive and expository are also considered [4]. Explicitly teaching strategies for each stage of the writing process has a strong impact on the quality of all students’ writing. Overall quality of student's writing improves when they are taught specific knowledge about how to write (i.e., test structure instruction), [5].
However, the ultimate purpose of writing is reader's comprehension. Every writing instructional method should include a focus directly on what will make the text comprehensible for the reader. Writing is not a process of merely communicating information; it is a process of communicating information effectively, in a comprehensive way. The writer's primary question or main goal to accomplish, regardless of content: how can I help the reader to understand my main ideas? A shift in attention is therefore needed from "what will be the main idea of the text" or "setting rhetorical goals" toward "how can I make the reader to comprehend what I want".
Considering focusing on reader's comprehension as a primary goal, writing processes like planning, translating, reviewing and monitoring will address the question: what text characteristics will help the readers's understanding process? Revising checklists of writing tasks should also include questions like "What writing strategies did I include to foster reader's comprehension"?
In classroom settings there is on overemphasis in learning to write, rather than writing to learn or writing for reader's comprehension. Writing and learning are regularly treated as discrete subjects. When teaching writing, students are usually instructed how to use strategies for identifying and summarizing main ideas, asking questions about texts, inferring. For example, strategies like

About/Point helps students distinguish between main ideas and supporting details. Graphic Organizers aids students in reading comprehension by providing a tool for organizing information and making connections across the curriculum, aiding in reading comprehension [4].

Reading and writing can be considered as analogous processes of composing. There are cognitive processes in writing which are reversed in reading [6]. In case of reading, we associate images and thoughts from our long-term memory to written signs (letters, words, sentences); associating these images and thoughts, finding causalities and temporal succession between them results text comprehension. When composing text we transcode knowledge, images and thoughts from our LTM in written signs. Theories of reading and writing processes suggests that they are interconnected, recursive processes of coding and decoding meanings in/from text messages [2]. Shanahan [7] recommends teaching reading and writing in conjunction.

In order to write for reader's comprehension in mind, we have to take evidence of processes included in reading comprehension. Metacognition is the process of reflecting, monitoring and controlling one's knowledge and thoughts [8]. Metacognition is probably the most important process responsible for learning efficiency [9]. It contributes to learning performance independent of intellectual ability [10]. Metacognition is often compared to self-regulation and self-regulated learning, (see [11] for an overview).

Metacognitive strategies in reading like forming and testing hypotheses about texts or identifying and summarizing main ideas has crucial effect on text comprehension [4, 12, 13]. Reading involves metacognitive processes working for text comprehension; writing, on the other hand might be considered as applied metacognition [14].

There are some text characteristics which facilitate the use of metacognitive strategies, making the text more comprehensible. Reading is a process of decoding individual letters and words, then a recording process, when we create larger, more meaningful chunk of information from the results of the decoding process. Therefore reading for comprehension requires splitting text into chunks. Readers figure out phrase- and clause-size information chunks for comprehension. Writing strategies like organizing information with graphical organizers and writing it accordingly will help the reader in chunking information for better comprehension. Research has shown that the nature of metacognitive judgments, that is, the criteria on which these evaluations are based, is an important factor in determining their accuracy [15].

The main goal of our study is to investigate the possibility of using writing tactics aimed at stimulating reader's use of metacognitive strategies, which should result in better text comprehension.

2. Method

In order to identify writing strategies for stimulating reader's metacognition, in a first step we have selected metacognitive strategies in reading which are suitable to be stimulated by specific writing considerations.

Type of written text has a role to play in choosing appropriate strategies for reading comprehension. Narrative and expository texts are most frequent in educational settings. Strategies used for comprehending these text types might differ, which has to be taken into consideration when choosing writing strategies for fostering reader's comprehension. Since expository texts are more often used in educational settings, we have decided to identify metacognitive comprehension strategies to be stimulated by writing considerations only for these kinds of texts, in a first step.

We have identified four metacognitive reading strategies suitable to be stimulated by specific writing tactics.

1. Before reading experienced readers motivate their reading activity by establishing the purpose of reading, like finding answers to interesting questions or a resolution for a problem [16-18] Inexperienced readers read texts monotonously, just for finding-out what is in it. We can enhance the motivation of readers with writing tactics like formulating questions to-be answered in the text, or pointing out what situations or problems can be addressed with the information from the text.
2. Experienced readers seek for connections between written information, like causalities, temporal successions, arguments for a statement, etc. This kind of thinking process can be supported by creating a semantic plan of the written information (like word webs/clusters). When putting information on paper, text should be fragmented in a way that information from a cluster to be included in one sentence or paragraph, accordingly.
3. Experienced readers chunks new information into a well-rehearsed, or known label, which helps in overcoming working memory limitations and memorizing [18]. Adding subtitles to every subtopic will help readers to draw on this mental process.
4. After reading, experienced readers check out and also deepen their comprehension by summing up the main ideas of the text [19]. By writing summaries the writer will prompt readers to recall the main ideas.

In a pilot study we have investigated the hypothesis if expository texts from textbook are written in accordance to these tactics, level of comprehensibility increases. We have selected a text from a 4th grade textbook (support for a

Geography class) and a 7th grade textbook (History). Both textbooks are in use in the Romanian education system. The two texts were rewritten or completed according to the four tactics mentioned: introductory questions to-be-answered in the text were formulated at the beginning, information details or arguments for an assertion were presented in a single paragraph, text were divided in sub-chapters with subtitles and a resume was written after each text.

Original text was presented to 9-9 fourth and seventh grade children (control group), and rewritten text to 9-9 children from the same classes (treatment group). Children were selected from an average school with the guidance of their teacher's advices. There were no prior classroom activities with the texts selected; however, children who have self-reported to read the texts before from curiosity were excluded from the experimental groups. Texts were presented on A4 papers, and children were instructed to read them in self-paced manner, two or more times if necessary, until they have comprehended them. After reading, there was a 10 minutes discussion in a topic not related to the text (e.g. what have you been doing in the holiday?). After the break they were given a paper-and-pencil comprehension text with four questions (two knowledge questions, and two comprehension questions, according to the first two steps of Bloom's taxonomy of thinking levels [20]. Children from experimental group significantly outperformed control group children, indicating that the four text-writing tactics increases text comprehensibility.

We have elaborated an educational program for teaching the four writing tactics in elementary grades. Five elementary school teachers were trained during an 8-hour training program to apply the method. The 75 children from their classes formed the treatment group. The four writing tactics were taught to 4th grade children during an 8-week period, three classes a week, 20-30 min. each class. Students learned how to rewrite textbook chapters using the tactics mentioned, moving to write their own expository texts applying the four tactics.

Eight teachers from regular classes were asked to give special attention to teaching writing strategies for eight weeks, at least three times a week. Children from their classes formed the false-treatment group (N=78). A third group of four classes formed the control group (N=69). There were no instructions given to these teachers. Every children included in this design experiment were in the 4th grade (mean age 9 years and 3 months). Classes from the three experimental groups were from regular schools, from rural and urban areas in approximately equal proportion.

Pre- and post-tests were applied in all three experimental groups. Children were requested to write everything they know about two familiar topics: vehicles and animals. Tests were taken by experimenters, following similar instructions.

Responses were coded according the following criteria: texts were broken down to phrases, the presence of introductory passages and information from the same semantic or logical category (e.g. arguments or details for a case) were included in the same paragraph. Two points were given if the text met the criteria, one point if the criteria was partially met (e.g. if there was a noticeable effort from the student to respect the criteria mentioned). Texts were evaluated by one of the teachers (although for children not included in their classes) and one experimenter. If the sum of the evaluations differed considerably (more then 3 points), the evaluators clarified the reason of the difference.

3. Results

We compared mean ranks of the three groups with the Wilcoxon signed-rank test. Results of children who did not complete pre- or postest writings, or who were missing more than 5 days during the 8-week training period were excluded from data analysis. Difference between pre- and post test results were significant in the treatment group, but not in the case of the control and false-treatment groups (although in the case of the later was almost significant, see table 1).

Table 1. Intragroup comparison of pre- and postest results (Wilcoxon test)

Group	Significance
Treatment	0.000
False-treatment	0.059
Control	0.578

We can conclude that training in using the four writing strategies was efficient.

Paired intergroup comparison of pretest results showed no significant difference between groups. Comparing posttest results showed significant difference for treatment-control and treatment-false treatment group comparisons, treatment group scoring higher in both cases. Comparing posttest results of false treatment and control groups resulted no significant difference (see table 2).

Table 2. Between-group comparison of pre- and postest results (Significance level resulted form Mann-Whitney test)

Gropus included	Pretest	Posttest
Treatment-Control	0.209	0.000
Treatment-False treatment	0.332	0.000
False treatment-Control	0.779	0.278

4. Discussion and conclusions

Reader's comprehension strategies should be taken into account when composing texts. Comprehensibility of expository texts increases when they are written in a specific manner of stimulating reader's metacomprehension strategies. Results suggest that when instructing well-investigated writing strategies by focusing on what influences reading comprehension, writing performance increases as indicated by the comprehensibility of written text.

Results have some limitations. Although as a part of the writing program the four writing strategies were selected with the primary goal of stimulating reader's metacognitive strategies, the goal of writing for reader's comprehension was not explicitly mentioned in the development program. However, findings suggest that when designing more complex development program should be elaborated where reading and writing strategies are instructed as different manifestation of the same cognitive processes - coding and decoding information with symbols - with deliberate focus on reader's comprehension processes.

Moreover, it would be worthwhile to investigate writing methods for fostering reader's metacognitive strategies in case of expository texts also.

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MANAGEMENT

CALCULATION OF COST FIXED ASSETS

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Abstract

Fixed assets are a fundamental requirement for economic activities, for a company, as well as a public institution. This paper deals with the topic of fixed assets and their spending, methods of calculating costs, i.e. amortization and impairment of fixed assets. This paper wishes to approach and explain what fixed assets represent to companies and public institutions in carrying out economic activities. In addition, the goal is to determine / explain the ways of calculating the cost of fixed assets with the help of accounting standards and legal regulations and determine the differences in the calculation in companies and public institutions and to explain why the differences exist.

Keywords:

fixed assets, amortization, impairment, accounting standards

1. Introduction

In order to start with its business, every company or a public institution first need to gather assets, what is done by various means and from various sources. The assets which the public institution gets from others or acquires during business are the assets of this economic subject.

Using fixed assets in a business process, i.e. economic activities, as a consequence has a physical and economic spending of its historical cost. For this purpose, the part of the historical cost that was spent has been calculated for each business year, which is then represented as a cost in financial reports, taking into account the demands of accounting and tax regulations.

The assets which succumb to amortization/ impairment are the assets which are expected to be used for more than one period, i.e. longer than 12 months, which has a limited usage time and is used for business purposes. Accounting procedures in relation to amortization are regulated by accounting standards, while the tax treatment of approving amortization costs of fixed assets is assigned by the income tax act and income regulations.

2. Fixed assets are both a notion and significance

Fixed assets are those assets that last for a period longer than one year. It is a basic prerequisite for doing business, in which fixed assets are permanently present and are not there for sale. Fixed assets are also called investment. They can be found in two basic forms:

The firs type are intangible assets such as business software and other types of license (rights to use intellectual property), patents used in business trademarks, franchises, etc. Their very important common characteristic is that the right to use them lasts for more than one year. Into these rights we also include financial property, such as stocks with the intention of holding them in a portfolio for more than one year, long term money deposits, for example in a leasing company, as a guarantee for an approved leasing , long term receivables for sold goods or services, etc.

Tangible assets are land, buildings or business space, machines, equipment, furniture, vehicles, etc) if they were bought for business purposes.

If the entrepreneur is also doing business with the above mentioned items, then the property is called stock or fleeting assets.[3]

Fixed assets are divided in accordance with their form features and function in the business process:

- ✓ Intangible assets
- ✓ Tangible assets
- ✓ Financial assets
- ✓ Long term receivables

3. Amortization and revalorization

From an economical point of view, amortization is a cost, i.e. expenditure, which occurs as a consequence of gradual spending of economical resources contained in assets with a limited usage time, i.e. which is amortized.

“A gradual exploitation of economical benefits of long term tangible and intangible assets in connected with its usage and making profits, which means that the arrangement of total amortization amount over particular years during its usage should allow an objective correlation between amortization as an expenditure and accomplished income.”[1,p.335]

Amortization can be calculated in time or function system.

Calculating amortization in a time frame is based on an assumed spending of basic resources in a given time period. Methods used in this system are:

- ✓ Linear, proportional or uniform (assumption: basic resources are spent in a steadfast manner, uniform amount figures of basic resources amortization during their duration). Linear method is the easiest to use. The cost will be steady, therefore the cost of amortization will charge the income in a steady manner.
- ✓ Progressive methods or methods of accelerated amortization (assumption: investments in the first period are considerably higher, pursuant to that, the results are lower than in the later period. Therefore the company is more and more burdened over time. With time, the amortization figures are higher, amortization rate, annual amortization and the value of basic resources is lower.
- ✓ Regressive methods of amortization are expressed by increasing the amortization rate determined when using the proportional method, the amortization percentage determined for proportional write-offs is increased by 50%, and as a basis for accounting – present cost and not historic cost is used.

Functional system of amortization assumes and is based on an actual usage of work resources, regardless of their life time. Methods in the functional system are:

- ✓ Value write-off method per product/service item (amortization is a part of the original, i.e. purchase price of the primary capital which charges the product item, and by multiplying the total product amount with the amortization amount per product item, you will get the total amortization number for the given primary capital. Amortization number as a cost is actually a production volume, i.e. it is in a direct relation to the produced goods or accomplished work effect.[4])
- ✓ Value write-off method on the basis of equipment working hours (in this way amortization is a direct expense. For some types of primary capital, by using the right instruments can measure the dynamic of their spending. Before using those assets you can measure their work capacity, expressed product amount or work hours, kilometers travelled.)

Depending on the choice of amortization, it can affect the financial placement and performance of a company, but there is no such influence in long terms.

Law states that for amortization accounting, a linear method should be used and that amortization is accounted singularly.[5]

For fixed assets write-off we use annual write-off rates which are defined by the amortization age of a particular fixed asset group, and these are things and rights whose individual procurement cost is higher than the amount stated by the law, i.e. 3.500,00 and whose life-time is longer than one year. This means that things and rights with the procurement cost higher than 3.500,00 enter into Fixed Assets Register (DI form), while things and rights which cost under 3.500, 00 enter directly into costs or expenditures.

While calculating amortization, annual rates prescribed by Article 12 of Corporation Tax Law, can be doubled. If amortization is calculated for a sum that is lower than allowed, it is considered to be a tax allowed expenditure. Write-off costs are approved as tax expenditure from the first day in a month which follows after the month in which fixed assets were put into usage. For sold, given or in any other way confiscated or damaged fixed assets write-off cost is approved until the end of the month in which it was used.

Amortization for private cars and other vehicles used for personal transport is allowed when the procurement price is not higher than 400.000,00 kn per one item. The amortization is approved for a price above the given only if the means of transport are used for a registered leasing or transport business. After the write-off, fixed assets are still included in the fixed assets register until the moment of sale, donation or any other ways of confiscation or damage. [6]

Revalorization as a method of subsequent measuring of fixed assets

After the initial recognition of fixed assets in account books, as a method of subsequent fixed asset measuring, in accordance with the accounting standards, entrepreneurs use the cost or revaluation method. By using the revaluation method, i.e. a subsequent measurement method, the entrepreneur displays his assets in an estimated amount which makes a fair asset value minus the accumulated amortization and accumulated loss, if there are any. In this case the entrepreneur has to take into account the fact that net asset value shown in the balance should not highly differentiate from its fair value.[7]

In order to estimate the optimal value of a real estate, an authorized estimator should be hired, while the estimation of other assets could be conducted by adequate administrative and professional service already employed by the entrepreneur.

When the accounting asset value is enhanced as a result of revaluation, this enhancement should be registered in entrepreneurs accounting books as revaluation reserves. Revaluation growth will be registered as an income only to the size of previous losses when it comes to the reduction of

the same asset, if there were any. Therefore, every reduction of asset value as a result of revaluation is classified as expenditure. This expenditure is classified as a reduction of revaluation reserve under the condition that the assets are formerly revaluated and if it exceeds the amount of revaluation reserve, than the difference is classified as expenditure. Revaluation reserve of fixed assets that has been under amortization is lowered by the usage of the property, i.e. amortization. The above mentioned is called realization of revaluation reserve, which also happens in cases of alienation or asset withdrawal. Realization of revaluation reserve is not completed through the calculation of gain and loss. The accomplished amount is transferred from the revaluation reserve to gained profit. The figure of realized revaluation reserve by amortization is the difference between the gross accounted cost of amortization of revaluated assets and the amount of amortization costs which would be calculated onto the original cost of fixed asset acquisition.[7]
During the realization process of the revaluation reserve of fixed assets, it is necessary to take into account tax regulations and legal directives, i.e. Income Tax Policy. According to the above mentioned regulations, realization of revaluation reserves is not acknowledged. Precisely, the basis for income tax calculation through an income tax entry should be enlarged for its amount, although the actual realization of revaluation reserves is not shown in the gain and loss account. All this, in accordance with the demands of accountant standards, results in expressing a postponed tax obligation in the moment of acknowledging the revaluation reserve.

4. Legal base of accounting

A company/entrepreneur or a public institution in the moment of acquisition, i.e. by activating the primary funds should estimate its useful economic life. On the basis of the estimated life time, amortization rate/ value alteration rate is being defined, by which the amortization amount is being arranged in periods where the primary funds will be on disposal.
The calculation of amortization is being governed by The Croatian Financial Reporting Standards; tangible fixed assets, intangible fixed assets, real estate investment and International Accounting Standards; real estate, facilities and equipment, loans, asset deduction, intangible property and business merging.
Amortization is also regulated by tax policies. The law decides which assets can be subjected to amortization, i.e. assets which are expected to be used longer than one accounting period (fixed assets), fixed assets with a limited usage period, fixed assets held by the company for manufacturing usage or merchandise selling, as well as for administrative purposes, real estate investment governed by the method of acquisition cost.
Accounting standards contain economic principals regarding amortization accounting, while the income tax law is necessary in order to identify the highest amounts of amortization allowed.
According to income tax law, the overall accounted amortization can be divided into two parts:

- ✓ Approved as tax expenditure
- ✓ Disapproved as tax expenditure

Approved amortization
Amortization as approved tax expenditure is governed by article 12 of the Income Tax Law. The given article states that amortization for tax purposes is determined by the usage of linear method at an expense of fixed asset acquisition. Here, the highest rates of amortization allowed by tax are permitted.
Disapproved amortization
Amortization as disapproved tax expenditure, when determining tax base, in accordance with article 7, paragraph 1, subparagraph 4 of the Income Tax Law, creates 30 per cent of amortization costs created in relation to a private or leased motor vehicle or any other means of personal transport of stakeholders, owners or workers, if the paycheck is not determined on the basis of using the resources for personal transport. In case the paycheck is being determined by these assets, amortization is fully approved tax expenditure.
We must highlight the regulations of article 12, paragraph 13 of tax income law which decided that amortization for personal cars and other means of personal transport are approved up to 400.000,00 kunas of acquisition cost per one vehicle. Therefore, if the asset acquisition cost is higher of the allowed amount, amortization above the given amount is not approved expenditure.
Article 22, paragraph 5 of the Income Tax Law states that asset amortization costs for those assets which are not used for a certain service are also not approved, and paragraph 6 of the same article states that good will amortization created by changes in status are also not approved expenditure.

5. Calculation of Companies

Companies, as tax payers expense, amortization as a business expense determined by applying economic principles from which entails the systematic and objective allocation of the depreciable amount of all periods in the lives of the individual assets. With the appreciation of the fundamental principles of management of each company should in general act to establish all the elements necessary for the calculation of amortization as a business expense.

Contrary to the economic demands for objective determination of amortization as a business expense in the lives of, the tax regulations shorter amortization life for tax purposes of objectively estimated useful lives and resulted from increased amortization to taxpayers to legally delay paying income tax. Although in the case of prescribed high tax deductible annual amortization rate is not required, however the purpose of the tax regulations and prescribing the maximum annual amount of tax allowable expense (the maximum tax allowable annual amortization rates) prevent uncontrolled arbitrarily delaying the payment of income tax by the very taxpayers profits. Specificity of tax rules on amortization in Croatia that were from 1 January in 2001. Years with high annual rates of amortization by Amortization Regulations (Official Gazette., No. 54/01.) Capabilities delay paying taxes on profits still increased through additional full or partial write-off in the year starting use. [8]

As previously noted, the rate of amortization (which applied by companies and dealers) for fixed and intangible assets whose individual cost greater than 3.500,00 prescribed by Article 12 of the Income Tax Act (Official Gazette 177/04, 90 / 05, 57/06, 146/08, 80/10, 22/12 and 148/13).

The amortization charge for sold, donated or otherwise disposed assets is recognized in tax expense by the end of the month in which the assets were in use. Undercoated cost of that disposal of fixed assets in the ledgers represents the rest of the carrying value of the assets is recognized tax expense in the period in which such property is sold or otherwise disposed of. Non-current assets is fully written off, keeps the records and reported in the balance sheet until the sale donations, destruction or other means of disposal. [8]

6. Calculation in public institutions

Public institutions as beneficiaries of budget funds not accounted amortization already implemented allowance or write-off of fixed assets. In other words, the value of fixed assets are written down or "correct" or reduced. So, on that basis is not recognized amortization expense.

The reason for not showing the amortization expense is provided in Article 21 of the Rules of Budget Accounting and Chart (Official Gazette 114/10 and 31/11) in conjunction with expression of expenditure and revenue, and stems from the fact that the total value of assets recognized as an expense in the the time of purchase. "Since it is not stated on the basis of amortization expense to a reduction in the value of fixed assets revaluation simultaneously recorded as a reduction of sources of ownership, without the use of sub-915.

This accounting treatment is prescribed in Article 20. Ordinance where it is stated that the impairment of assets reduced by own resources. "[2, p.63]

Rates Impairments of fixed assets

The value of fixed assets written off / corrected by applying the annual rate correction values for all budget users including public institutions laid down in the Budget Accounting and Chart (Official Gazette 114/10 and 31/11).

The basis for the implementation of the annual rate of the allowance is the purchase value or estimated value at the time of acquisition if we did not know the value. Accumulated depreciation on these assets is done once a year, usually at the end of the year and should not be performed more frequently because the changes are recorded only in the assets and liabilities of ownership and that means you do not have an impact on the formation of expenditure. Data on fixed assets in accounting is necessary to take into account couples / bills and for non-current assets are written down regulated accounts / allowance account 019 and 029.

According to Article 19, paragraph 2 of the Ordinance on budget accounting, as applicable from the beginning of 2011., Limit classification of fixed assets in the "small items" increased from HRK 2,000.00 to HRK 3,500.00. Such long-term assets can be, but does not have a one-time write-off.

7. Conclusion

A company or a public institution as an economic agent in a business process spends its assets. Fixed assets are gradually spent in the business cycle. The decrease in real value of fixed assets either by physical spending or economic aging is called amortization. Therefore, amortization of a primary fund is an economic reflection of gradual spending and value decrease in the business process.

Income Tax Law regulates amortization rates as approved amortization expenditure. Company management is obliged, either by accounting politics or amortization policy, to establish the methods and ways of accounting amortization.

When the highest rates of amortization, accepted by the taxes are being used, from an accounting point of view, balance does not express a real/ objective financial situation. Gaining report does not express a real business result.

Amortizable assets, the balance sheet is understated for the difference in amortization between the amount amortization at the rates set forth in the regulations of the higher amount of amortization to the application of tax allowable amortization rates. In the statement of income and expenditure is recorded profits undervalued for the amount of the difference in amortization.

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THE FINANCIAL CRISIS AND ITS EFFECT ON THE QUALITY OF GOVERNANCE AND THE FINANCING OF THE CULTURAL SECTOR

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Abstract

The European Union member states use various cultural financing models. Some of the countries prefer the dominance of the market therefore the government creates an institutional system, in which the arm length aspect has priority. Other countries believe in the direct political and fiscal role of the state. However in both aspects the quality of governance has a major role in the efficient functioning of the system. As the result of the financial crisis in 2007–2009 in many EU countries the level of decentralization increased as mostly the central government budgets were cut, while the regional or local governmental budgets stagnated or increased. This change in the ratio of the central and local cultural budget and the increase of decentralization during crisis raises the question why decentralization has still dominance in the cultural policy of the European Union and its member states.

We assume that the quality of governance and its institutions has effect on decentralization as the higher the quality of governance is, the higher the transparency is, the trust between the central and local government actors stronger is and the level of corruption lower is. In this article the connection between the quality of governance and the type of decentralization is examined. In the analysis the Worldwide Governance Indicators and the central and local cultural budgets of 22 EU Member States are compared The main question is how the quality of governance and the level of decentralization changed becasue of the crisis.

Keywords:

financing of culture, quality of governance, decentralization, European Union, crisis

1. Introduction

The European Union's motto is "*unity in diversity*". The European Union has supranational regulations on the audiovisual, the book sectors, on national heritage and copyright in the cultural area. EU cultural projects such as the European Capital of Culture, the MEDIA program, the book translation project and other minor programs, all were created to help understanding each other's culture and bringing these cultures closer to each other. *Hayek* in his famous book "*The Road to Serfdom*" argued that the main European values are *Christianity, Tolerance and Democracy* [1]. These values are embedded in culture so they are becoming more and more accepted and used in the practice of the European Union's supranational cultural political level as the decision-makers realized the social, political and economic potential of the cultural sector. In 2005 *Barroso* declined the importance of culture in the common European policy. However the communitarisation process in the field of culture is lagging behind comparing to other sectors as the European Union implemented rules only on a few cultural fields and the financing of culture is also delegated to the member states. Based on these facts we argue that the decision-making and the fiscal resource allocation are *decentralized* in *the European Union on the supranational level* as these tasks are delegated to the national level.

There is *no unity* in the strategies used by the 28 member states of the European Union. The European Union does not force a best practice model on the member states either in cultural policy or in the financing of culture, so all the member states have the opportunity to create and develop their own cultural strategies.

In this article the focus is on how the crisis modified the quality of governance and the central and local government expenditure on culture.

The second chapter of the article explains why the active role of the state is important in the cultural sector. In section three the pros and contras of decentralization are introduced. In the main chapter of the article the Worldwide Governance Indicators and the central and local government budgets on recreation, culture and religion of 22 EU member states are compared[1]. The article ends with the concluding remarks based on the results of the analyses.

2. The Role of the State in the Cultural Sector

The state is the biggest subsidizer (legal, political, financial) of the cultural sector in most of the

[1] No statistical data is available on Croatia, Cyprus, Malta, Latvia, Lithuania and Romania.

countries. Even in the most liberal countries, such as the USA, the UK or Australia, the role of the state is the most dominant in the cultural sector. These countries prefer the dominance of the market therefore the government creates an institutional system, in which the "arm length" aspect has priority. In these countries there is decentralised fiscal resource allocation and decision-making, bottom-up institutional development, the role of independent arts councils is determining, the entrepreneurial aspect among the actors of the cultural sector is very strong, there is highly developed non-profit sector and there is strong competition for state and private subsidies, consumers, media attendance and artists. This model is used in the most transparent way in the United Kingdom in the European Union.

The other group of countries believe in the dominance of the state as the decision-making and the resource allocation is centralized, the direction of the institutional development is top-down way, there is lower level entrepreneurial aspect and competition.

Although there are many differences how the coordinated and the liberal aspects define the role of the state now we list those fields where the role of the state is more than necessary in both models.

Most of the cultural goods and services have the common goods characteristics, which mean that these goods and services have to be accessible for the people (citizens, tourists) free of charge. However these goods and services also have costs, which have to be covered. The role of the state is determining in this process to cover the cost of common goods.

Many of the cultural goods and services have the special meritocratic characteristic, that the actors cannot estimate the importance of these goods and services with using their own preferences. The critics take the role as they share their opinion with the public and based on these opinions the consumer decision-making is supported. The critics mostly financed from public money, so the active role of the state appears in this process as well.

The legal system is a key element in the effective functioning of the cultural sector. The intellectual property rights protection is the major shelter for the artists and the owners of the cultural goods, which can be created by the state. The law-making role is also important to create institutional background for the functioning of public, private and non-profit cultural institutions. The tax incentive rules make it possible to involve the private sector to sponsor and donate cultural activities. In more and more countries the lottery became an important source of financing culture. The law on lottery is also made by the state.

Baumol and Bowen [2] in their famous article described a very interesting paradox called the cost disease. The paradox is that the production cost of cultural goods and services is increasing, while the output is almost stagnating. This phenomenon is against the classical economic theory that the increase in income generates higher productivity. Baumol and Bowen illustrate the paradox with an example from the music sector. 4 musicians are needed to play a string quartet. There could be slight differences in the interpretation, but the length of the piece would not change significantly, however there is a significant increase in the musicians' salaries, especially from the 19th century. The state enters into the scene as the increased costs are very often covered form public budget.

Since the 1960s the democratisation of culture (access to culture for everyone) became the main slogan of the national and supranational cultural policies. The income gap between the social classes creates different possibilities to have access to culture. The governments give financial support (tax reduction, free entry, free open air cultural festivals, cultural program on TV) to increase the accessibility of cultural goods and services for the all the social classes of the society.

The financing of archival activities is a key role of the state as the society is not able to inherit culture properly from one generation to the other.

The cultural goods and services generate the spill over effect, as they have influence on other sectors of the economy. The state intervenes mainly in case of negative externality, for example when the open air festivals' volume exceeds the limit. Luckily there are many positive examples for the spill over effect in the cultural sector too. The museum shops, the restaurants around touristic attractions are examples of it. Although the running of a museum can have deficit for the state, but the rental fee, the taxes of the cultural goods and services generate income for the state budget, so the balance could be positive in total. The role of the state here is to create an institutional system, in which there is trust between the state and the private sector, the system is predictable, transparent and accountable.

In the first paragraph of this chapter we described the main characteristics of the coordinated and the liberal cultural financing models. It is clear that the coordinated system is mostly centralized, while in the liberal countries decentralization has priority. The state decides whether to use a centralized or a decentralized system in the cultural sector. As decentralization of the cultural sector is in the scope of this article now we turn to examine, which are the pros and contras of decentralization.

3. Decentralization and/in Culture

Decentralization is implemented into practice in a country if there is *deconcentration*, *fiscal decentralization* or *democratic decentralization*.

Some form of decentralization can be present in democracy, autocracy or transitional cases, however if deconcentration is not combined with democratic decentralization it results in centralization. Furthermore if a system has centralized decision-making with fiscal decentralization the result is a pseudo decentralised system, which cannot be regarded as a democratic decentralized system [3].
A real democratic decentralized system comes together with capitalism and the active role of the civil society. The decision-making, the fiscal resource allocation all delegated to the lower intermediate and/or local level elected representatives. In this system there is top-down and bottom-up accountability at the same time, so the local level elected representatives have the right to control the central government and the civil society has the accountability right above the local representatives. The direction of accountability can be the other way around too.
If decentralization works well in a country the speed of problem solving, the quantity and the quality of solutions increases, so the overall performance of the system develops. These values can be guaranteed with quality governance [3].
These arguments support why it is worth analysing whether the quality of governance has effect on decentralization in the cultural sector.
Cowen [4] believes that decentralization supports innovation, entrepreneurship, charity and generosity, which are all active motivators of culture.
Kawashima [5] in an excellent paper explains how decentralization can be implemented in a special segment of the economy (*the cultural sector*), in which the dominance of the state exists. In the cultural sector we speak about *cultural, political and fiscal decentralisation*. The theatre or museum exhibition country tours are typical examples for *cultural decentralization*, when the cultural goods and services are brought to the consumers (*democratisation of culture*, *to have free access for everyone to consume culture*). The *political decentralization* (*deconcentration*) means to empower the decision-making right to lower lever elected representatives. *Fiscal decentralization* exists in a country if the regional and/or the local governments are the main allocators of the cultural budget.
In the cultural sector there are different combinations for political and fiscal centralization and/or decentralization.
The system is homogenous when there is political and fiscal centralization or decentralization. Two hybrid models exist, one is when political centralization is combined with fiscal decentralization like in *most of the post-socialist countries* or political decentralization is together with fiscal centralization like in Slovenia.

Based on *Manor*'s [3] definition we speak about *real decentralization* only when political and fiscal decentralization comes together. The system has to be regarded as being partially decentralized if there is either fiscal decentralization or deconcentration in a country.
The literature [3,6,7] explains why it is hard to achieve real democratic decentralization in practice. First of all the constitutional and legal frameworks have to be clearly defined and enforced. The local governments should have access to the necessary resources. The quality of public expenditure management system can guarantee the efficiency of fiscal allocation with its monitoring and controlling function. The equal quality of local and national bureaucrats is a necessity, as the national level has more opportunity to employ the highly qualified experts.
Beside these constraints there are examples that decentralization can function in practice. If decentralization has priority in a country's political, economic and social system it is more likely that the system works more efficient, as decentralization increases information accessibility, the independence of the civil society and the local governments. The cooperation between the public and the private sector is more vital. The governmental work is more transparent for the local representatives and the civil society. Corruption can be a problem on the local level in a decentralized system, but with the quality of governance, transparency and accountability it can be reduced.
As a summary we can state that it is very hard to create a democratic decentralized system, but decentralization can live up to its promise if the previously mentioned criteria are implemented in practice. In the next chapter we check how many of the EU member states are able to create a democratic decentralized system in their cultural policy. We also examine how the crisis modified the quality of governance and the level of decentralization in the cultural sector.

4. The Comparative Analysis of the Main Statistical Data on Quality of Governance and Decentralization of the EU member states between 2000-2007 and 2008-2010

In this section the aim is to compare the EU member states how the crisis had effect on the quality of governance and the ratio of the financing of culture both at central and local government levels.

4.1. Methodology

The Worldwide Governance Indicator (WGI) demonstrates the quality of governance in a country. Six broad dimensions of governance are measured with this indicator [8]:

- Voice and Accountability
- Political Stability and Absence of Violence/Terrorism
- Government Effectiveness
- Regulatory Quality
- Rule of Law
- Control of Corruption

In the analysis we use the WGI indexes of 11 years between 2000 and 2010. To see how the WGI changed by the crisis, we take the average of the years 2000-2007 and 2008-2010.
If we compare the main characteristics of a decentralized system and the dimensions measured by the WGI index, we can see that all the criteria of democratic decentralization appear in these dimensions and a strong and high quality governance is needed both on the central and local level to achieve decentralization. The cultural sector is no exception.
What do we mean under culture? Nowadays it is accepted among cultural economists to take the broader dimension of culture [9]. We accept this view so when we speak about culture we mean recreation, culture and religion as being part of it. In the analysis the so called *COFOG database*[2] [10] of the OECD is used to demonstrate how much the central and local governments spend on recreation, culture and religion in the examined 22 EU member states. The central and local government budgets are measured in national currency, current prices and in millions. In the analyses we use the cross-country comparative method, so the previously introduced variables of the EU member states are compared. To see how the ratio of local/central government support for culture changed by the crisis, we take the average of the years 2000-2007 and 2008-2010. The research questions of the article are the following:

- Did the level of quality of governance change significantly by the crisis?
- How did the crisis affect the level of decentralization in the financing of culture?

4.2. Comparative Analysis

Table 1 shows how the level of the quality of governance and fiscal decentralization changed because of the crisis. If we take the average of the 22 countries we see that there is a very little negative modification in the quality of governance. This negative change appeared mostly on the central government level. The change in the ratio of local and central government budget on culture is much more significant.
The results support theory. The crisis immediately hits the functioning of the central government level. The effect of the crisis reaches the local governments later. If the central government has problems in financing an area, such as the cultural sector, it makes immediate financial cuts. However the local governments can use a different strategy as they know the local needs, opportunities better, so can find other solutions than make immediate cuts. That is the reason why the ratio of local/central government budget on culture increased as a result of the crisis.
The biggest negative change of the quality of governance was in Greece, Hungary, Italy, Portugal, Spain and the United Kingdom. The crisis positively influenced the quality of governance in the Czech Republic and Poland. All the other countries had very minor positive or negative changes, so they are regarded as being stagnant.
Decentralization increased the most in all the federalist countries such as Austria, Belgium, Germany, Spain, plus in the Netherlands and Poland.
Fiscal centralization became stronger in Denmark, Finland, France, Greece, Ireland, Italy, Slovenia and United Kingdom.

Table 1. The Statistical Data of 22 EU Member States on the Quality of Governance and the level of Decentralization in the Cultural Sector

Country	Change of WGI (2008-2010) – (2000-2007)	Change of the Ratio of Local/Central Government Budget for Culture (2008-2010) – (2000-2007)
AUSTRIA	-0,09	46,64
BELGIUM	-0,03	308,01
BULGARIA	-0,01	20,13
CZECH REPUBLIC	0,10	16,34
DENMARK	-0,03	-6,83
ESTONIA	0,07	7,22
FINLAND	-0,06	-22,14
FRANCE	0,00	-16,23
GERMANY	-0,05	61,83
GREECE	-0,34	-16,88
HUNGARY	-0,22	12,68
IRELAND	-0,05	-19,70
ITALY	-0,17	-2,60
LUXEMBOURG	0,00	2,91
NETHERLANDS	-0,05	41,45
POLAND	0,20	48,63
PORTUGAL	-0,18	29,90
SLOVAK REPUBLIC	0,07	20,74
SLOVENIA	0,00	-11,15
SPAIN	-0,21	92,69
SWEDEN	0,03	4,62
UNITED KINGDOM	-0,14	-9,73
Average	**-0,05**	**27,66**

5. Conclusions

In this article we tried to analyze how the financial crisis changed the quality of governance and the level of fiscal decentralization in the cultural sector of 22 EU member states. We assumed that both the quality of governance and the level of decentralization changes significantly. However the results modify this assumption as the average of quality of governance almost stagnated, but the increase of decentralization is significant. During crisis the central government tries to solve the problems with stronger political centralization, but at the same time the state budget has to be cut, so fiscally the local governments' role increases. This

[2] COGOG is an acronym: Classification of the Functions of Government

tendency can be seen in the cultural sector of the examined 22 EU member states as well.

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RESEARCH OF KNOWLEDGE AND SKILLS EFFECTS ON ACHIEVEMENT OF EMPLOYEES AIMS

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Abstract
In modern society, duration of knowledge is shorter than ever and it is necessary to continuously adjust educational curricula, as well as to introduce long life learning. The aim of the research presented in this paper is to analyse the problems faced by employees in the workplace, concerning the lack of specific skills and knowledge. The results presented in this paper indicate the need of improving the process of advanced training of employees, which would increase the satisfaction of employees, and thus contribute to stability and growth of an organization.

Keywords:
Knowledge and skills, Long life education, Satisfaction of employees

1. Introduction

Knowledge has a strategic importance in developing unique capacities of organization and in providing them with sustainable competitive advantage is in an interaction with all the activities of business Job satisfaction is an element of organizational behavior and indicate that the expectations and needs of the workers are well-understood and effectively met. Job satisfaction is described as a function of individual's job-related expectations and the results he obtains when he does the job, [1].

The study of satisfaction with career development and achievement of personal goals of employees should be placed in the time, social and cultural framework. In today's business environment, the organizational culture increasingly interacts with national and international culture.

To achieve personal and career goals, except formally and informally acquired knowledge, another requirements are important nowadays, such as continuous learning through experience, developing of social skills, improving decision-making processes through managing the increasing amount of information. This study aims to investigate the relationship between the knowledge and satisfaction with career development

Hypothesis: There is a relationship between employees perception of their knowledge and their satisfaction with career progression.

2. Place and conditions of research

Economic environment of Serbia in the second decade of the twenty-first century is the period after a long and difficult transition, which included changing the entire economic structure of a country, the reform of political and legal system, opening and liberalization of economy, the privatization of state enterprises, the creation of institutions and mechanisms for investments.

De-industrialization and decline of activities of the Serbian industry and economy is the process that takes nearly a quarter century and is characterized by: narrowing of industrial production; devastation of industrial capacities; reduced productivity in the industrial sector; out-of-date industrial equipment and technologies; decline in the competitiveness of major industries and companies, especially those with export ambitions**;** decreased the share of industrial sector in GDP of Serbia; decline in export activities; reduction of the number of employees in the industrial sector, etc., [2].

According to the Survey on labor employment in April 2010, using adjusted methodology of International Labor Organization, the unemployment rate was 20.1% and the employment rate is 47.2%, which was unfavorable compared to the EU, [3].

Young people are facing with special employment problems because of the economic situation in the country and there is a big brain drain because young educated people possessing knowledge and technical skills are leaving the country, seeking opportunities abroad that are not open to them at home. There is no comprehensive data on how many people have left Serbia in the last 20 years, but that figure is estimated at around 300,000.

As is the case with well developed countries in Europe, Serbia is facing an increasing problem of pension system sustainability. In addition, after privatisation of state enterprises, large number of middle aged employees (50 years and more) has been left jobless. Although not officially admited,

besides sex discrimination, also age discrimination is present when looking for a job.
The research programme covered a sample of 35 economic entities both from private and public sector (small and medium enterprises, large economic systems, domestic and foreign companies), with different ownership structures, different number of employees and different economic sectors (health service, agriculture, tourism and catering, public administration, civil engineering, industry and services).
The research was conducted through a survey of employees, based on a sample of a total **138 respondents**, during the period from March to July 2013. on the territory of the Republic of Serbia. The results of examining the entire sample are enclosed, and they are classified according to the organization, gender, educational structure, length of service, age, position in the organization.

3. Independent variables

There were five differentiated **age categories**: up to 25; 25-34; 35-44; 44-55 and over 55 years.
Five categories of educational level were observed:
primary school; secondary school; bachelor degree; master degree and PhD (Doctor of Science).
The position in the organization was observed through five categories: worker; expert; lower-level managers (first-line managers); middle-level managers and top-level managers.
The length of service was observed through five categories: up to 5 years; from 5-10; 10-20; 20-30 and over 30 years.

4. Dependent variables

The research has included following dependent variables:

- satisfaction with knowledge
- satisfaction with communication,
- satisfaction with initiative,
- satisfaction with applying knowledge,
- satisfaction with position,
- satisfaction with advancing based on the knowledge

There was a questionnaire made up for the research needs, with dependent variables observed in two states, the current one and the desired one. For each question there were five offered answers which represent attitudes categorized according to **Likert scale**[3]:

1. I strongly disagree,
2. I do not agree,
3. I do not have an opinion (undecided),
4. I agree,
5. I strongly agree.

The degree of satisfaction we have observed through categorical scale:1- very disatisfied; 2- disatisfied; 3- neutral; 4- satisfied; 5- very satisfied.

5. Sample description

Sample comprises 138 respondets with the education, age, professional and sex structure, as follows.
Educational structure - 2% of the respondents have primary school, 41% have high-school education, 43% have higher education and 14% have master degree.
Age - The highest percentage of the respondents (38%) is between the age of 35 and 44, 33% are between the age of 25 and 34, whereas only 4% of the respondents are up to 25 years of age, 17% are between 44 and 55 years old, and 8% of them are over 55 years old.
Length of service - 19% of the respondents have less than 5 years of service, 27% have 5-10 years of service, 30% have 10-20 years of service, 16% have 20-30 years of service and 8% have more than 30 years of service.It may be noted that 75% of the respondents are under the age 45 years.
Position in the organization - 50% of the respondents are in the position of a top-level manager, 20% are middle-level managers, 13% are lower-level managers, 12% are experts, whereas only 5% are workers. As much as 83% of the sample are managers.
Professions - Economists are present with 46% of all the respondents, phylologists with 1%, legal branch with 12%, technical with 14%, medical with 1%, organizational (administrative) with 5%, and other with 20%.
Ownership structure- According to the sample data, the highest incidence of respondents is that of LLC - 30%, 27% of them are from public utility companies (public agencies and organizations), 21% are from joint-stock companies, and 22% of the respondents are from private enterprises.
Gender- The incidence of female respondents in the sample is significantly higher than that of the male respondents: 67% versus 33%.

6. Results: comparison of the current and desired situation

Figure 1 presents levels of current and desired satisfaction with communication, initiative, application of knowledge, progression, position based on knowledge. There is a noticeable difference between them.
In interpreting the results it should be in mind that the sample consists mainly of managers. Since they are generally hierarchically highly ranked in

[3] A type of attitude scaling that consists of a series of claims devoted to different aspects of a certain attitude. It is given to a respondent with the task of expressing the level of their agreement or disagreement for each and every claim, in a five-level scale, as a rule, in a following way: „ I strongly disagree ”, „ I do not agree ”, „ I do not have an opinion (undecided) ”, „ I agree ”, „ I strongly agree ”.

companies, degree of their satisfaction with the present state is mainly positive, ie with no discontent.
The result of the research indicates that the smallest difference is between the current and desired state in communication and a somewhat bigger difference is in the opportunities of the initiative, and even higher in applicability of what has been learnt, carreer advancement and perceptions that the more knowledge they have is related to higher progressions in their careers.

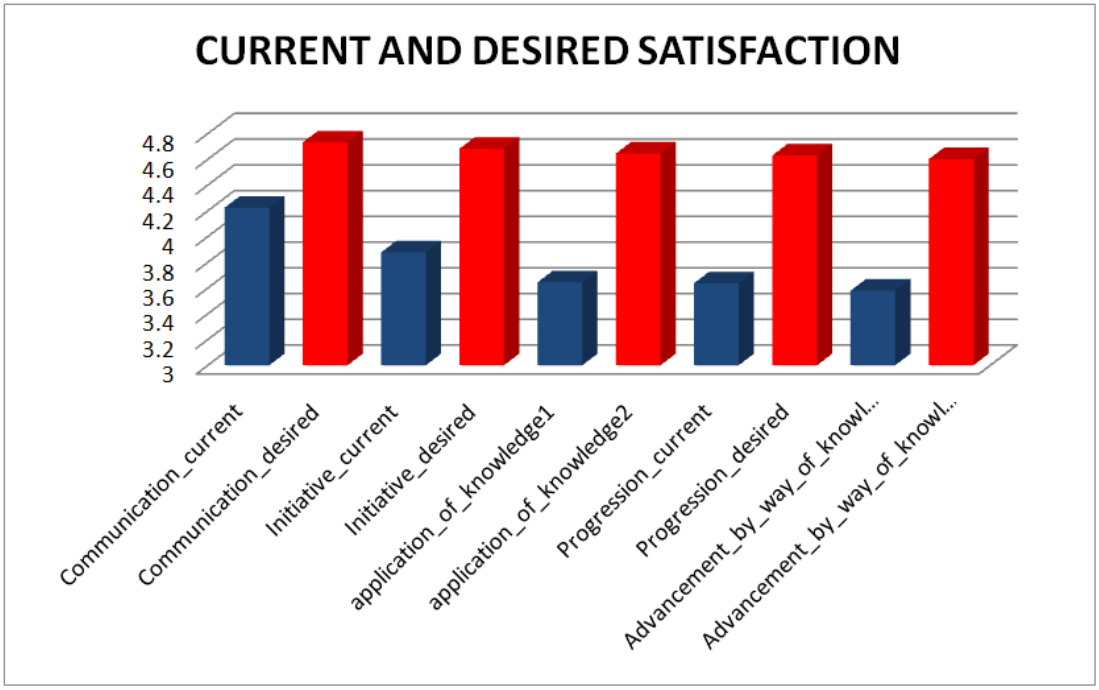

Figure 1. Current and desired satisfaction

To answer to the question whether it is significantly different satisfaction with communication, initiative, applying knowledge, position, advancing based on the knowledge in the current state and the desired state, we applied a paired sample t-test (which is used to determine whether there is a significant difference between the average values of the same measurement made under two different conditions). Table 1 shows descriptive data of paired samples, the mean values and standard deviation of examined variables in present and desired state.
Results of T test application are given in table 2.

Table 1. Paired samples statistics

		Mean	Std. Deviation	Std. Error Mean
Pair 1	Communication - current	4.2246	.83725	.07127
	Communication - desired	4.7319	.54759	.04661
Pair 2	Initiative - current state	3.8768	.96246	.08193
	Initiative - desired state	4.6812	.54015	.04598
Pair 3	Application of knowledge - current state	3.6449	1.12568	.09582
	Application of knowledge - desired state	4.6449	.62550	.05325
Pair 4	Progression – current	3.6377	1.24362	.10586
	Progression - desired	4.6304	.79300	.06750
Pair 5	Progression by way of knowledge - current state	3.5797	1.13222	.09638
	Progression by way of knowledge - desired state	4.6014	.82427	.07017

Table 2. Paired sample test

		Paired Differences					t	df	Sig. (2-tailed)	Eta squered
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference					
					Lower	Upper				
1	Communication current – Communication desired	-.507	.906	.077	-.660	-.355	-6.576	137	.000	0.239
2	Initiative-current Initiative-desired	-.804	.934	.0796	-.962	-.647	-10.108	137	.000	0.427
3	Application of knowledge – current Application of knowledge - desired	1.00	1.189	.1013	-1.200	-.780	-9.872	137	.000	0.415
4	Progression-current Progression-desired	-.993	1.193	.1016	-1.194	-.792	-9.775	137	.000	0.410
5	Advancement by way of knowledge-current Advancement by way of knowledge- desired	-1.02	1.193	.1015	-1.222	-.821	-10.062	137	.000	0.424

Since the value of Sigm (2-tailed) is less than 0.05 for all paired variables, one can conclude that there is the significant difference between present and desired satisfaction with communication, iniciative, knowledbe application, advancement in general and advancement related to knowledge. In all cases desired values of satisfaction are higher than present ones, producing the negative difference of mean values, as given in the first collumn of table.

The effect size has been calculated by using eta square, as given in the last column. Interpretation of this quantity has been given by Cohen (1988, str 284-287): 0.01 - small difference, 0.06 - intermediate difference, 0,14 and more - large difference.

Since all obtained values are greater than 0.14, the difference between present and desired state is large, especially when analized satisfaction with personal iniciative, knowledge application, progression in career and progression related to knowledge.

This result is of special interest beacuse 83% of the respondents are managers, indicating significant space for improvement of knowledge and skills of employed managers toward fulfilling their ambitions.

7. Correlation of independent and dependent variables

In order to establish relationship between independent variables: education levels, age structure, job position and longtivity and dependent variables: satisfaction with knowledge, satisfaction with knowledge of foreign languages, satisfaction with computer skills, communication skills, initiative, application of knowledge and advancement, we calculated the Pearson's coefficients of correlation, table 3.

Table 3. Pearson correlation

	Education	Age	Position	Length of service
Knowladge	.182(**)	0.029	0.095	0.055
Foreign language	.305(**)	-.229(**)	0.063	-.149(**)
Computer	.233(**)	-.141(**)	.128(*)	-0.043
Communication	0.009	0.093	0.06	.147(**)
Initiative	0.078	.132(*)	.193(**)	.164(**)
Application of knowledge	-.119(*)	0.072	0.066	0.096
Knowledge-position	-.124(*)	0.026	-0.023	-0.053
Higher education a better position	-.206(**)	0.03	-0.071	0.008
Advancement by knowledge	0.091	-0.005	.254(**)	-0.035

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

According to Cohen (1988), if r is between 0.1 and 0.29 it is about weak correlation; if r is between 0.3 and 0.49 it is about medium correlation and if r is between 0,5 and 1,0 it is about strong correlation, results of correlation indicate:

- Weak positive correlation between satisfaction with knowledge and education level (r = 0.182).
- Medium strong positive correlation between education level and satisfaction with knowledge of foreign languages, (r = 0.305) and weak positive correlation between education level and computer skills, (r = 0.233).
- Weak negative correlation between the satisfaction of computer skills (r = -0.141) and knowledge of foreign languages, (r = -0.229) and the age structure, which means that older employees are less satisfied with the knowledge of foreign languages.
- Weak positive correlation between satisfaction with communication and job longivity(r = 0.147), indicating possibility of communication skills development.
- Weak positive correlation between age and the length of service and satisfaction with initiative (r = 0.164).
- Weak negative correlation between formal education and practical application of knowledge (r = -0.119) indicating low applicability of what has been learnt.
- Weak negative correlation between formal education and attitude that it enables better job position at work (r = -0.206). This indicates the need for development of other, unformal skills and knowledge.
- Weak correlation of work position and advancement related with knowledge (r = 0.254).

In order to analyze the relationships between satisfaction with position, promotion, participation in decision-making and perception of the progress we have observed a correlation between the dependent variables, table 4.

Table 4. Pearson Correlation between dependent Variables

Pearson Correlations			
	Decision making	More knowledge a better position	Progression by knowledge
Higher education a better position	0.1	.590(**)	.442(**)
Progression	.196(*)	.435(**)	.617(**)
N	138	138	138

We have got a strong positive correlation

- between the attitude in which the higher formal education provides a better position and the attitude that more knowledge provide a better position, (r = 0.590),
- between the satisfaction with progression and the attitude that progression is rising by improving knowledge, (r = 0.617)

We have got the medium positive correlation

- between the satisfaction with progression and the attitude in which more formal knowledge provide a better position, (r = 0.435)

We have got the weak positive correlation between the satisfaction with participation in decision-making and satisfaction with progression in work.

8. Conclusions

Results of investigation performed on a sample dominantly comprising of managers in after transition period in Serbia indicate the need for a long life education concept to be impelemented in career development.

Result has shown a negative correlation between age structure and knowledge of computer technology and foreign language skills. The authors of this study believe that the result of the survey on a sample of lower-ranking workers would be much worse and that the lack of necessary knowledge is one of the reasons for high unemployment, especially in middle age workers.

The results showed that there is a weak negative correlation between satisfaction with knowledge based position, knowledge and education level and weak negative correlation between formal education and practical application of knowledge. It indicating low applicability of what has been learnt and weak negative correlation between formal education and attitude that that formal education enables better job position at work is connected with economic and social situation in the country.

Obtained results have shown big difference between current and desired satisfaction with skills important in business, indicating the need for continuous managers development.

As life expectancy increases and companies do not promise lifelong security and many workers will need to make major changes during middle age.

This shows that the relationship between knowledge and career development exist, but that it is not only connected to a formal knowledge. It means that satisfaction in career development requires the acquisition of new knowledge that is not taught only through formal education.

To make successful transitions, business people must stay open for the possibilities their experience qualifies them. In that proces they have to remain realistic about what they can achieve. Thereby, it is necessary to apply concept of „self-enhancement“ (Fiske's 2004). The tendency for

individuals to self-enhance results in attribution about life outcomes (e.g. Hastorf et al.1970), differences in intergroup behavior (e.g.Polzer et al. 1977), sources of identity investment (e.g. Eccles and Wigfield 1995), and behavior in interpersonal relationships (e.g., Tesser 1998), [4].

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NEW PRODUCT – THE KEY FACTOR OF COMPANIES' DEVELOPMENT

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Abstract
Innovation is the most important factor that pushes the company forward, allowing it to continuously create added value, in order to satisfy the needs of consumers, and existential needs of the company. Existing products have a limited life span and must be replaced by new products. Companies that in its operations do not introduce new products, they lose the basis for survival compared to those who successfully adjusting to change. The innovative product is even more appreciated as a key component of sustainable development of many companies. However, the new products cannot succeed without risk. The risks of innovation are also great as her prize. The key to successful innovation lays in the work the entire enterprise, strong planning, marketing focus and systematic process of developing new products.
Aim of the paper is to show the role and importance of new products for the survival and growth of the company and analyze innovative activities of companies in the European Union in relation to Croatia.

Keywords:
innovation, company, new products, development

1. Introduction

For successful companies, innovation is part of their everyday life. Without innovation activities such as the development of new products and services, it is questionable the existence of a company. The key to successful new product lies in the work of the entire company, strong planning, marketing focus and systematic process of developing new products. The process of innovation is defined as the steps that a manager must take in order to realize creative ideas. Creativity in finding new ideas plays a significant role.

2. The role of innovation in business

Innovation can be defined in several ways, considering its scope and type of innovation. From the viewpoint of managing, innovation is a process that applies the new ideas on improving organizational processes, products or services. [1, p.459.] The innovation is the use of new technological and market knowledge in order to offer a new product or service that consumers will want." [2] "Innovation in company is procedures of introducing new or improved existing products and services or processes." [3] Innovations in business are described as activities that are new or different from existing ones and represent a process that must be managed. Traditionally, all these innovations represent incremental innovations, small and predictable performance boost technology. If innovation is so important that changes overall technological development, innovation is considered to be radical. Accordingly, there is a division into two basic types of innovation: incremental and radical.

3. New product as a key factor of companies' development

Considering the intense competition of today in most markets, those companies that never manage to develop new products are exposed to great risk. The process of introducing a new product on the market can be very risky and may involve a significant investment in time and money. But the greatest risk is not to innovate, because it guarantees the ultimate destruction of the company." There are six categories of new products: Products that are new to the world, new production lines, addition to existing product lines, improvements and revisions of existing products, repositioning, cost reduction [4, p. 634]
Discovering the factors that contribute to the success of a new product becomes one of the major management concern, not only because the success of the new products is the main source of better positioning and survival of the enterprises, but also because it may indicate a previously undiscovered business opportunities.

4. Analysis of innovative activities of enterprises

Innovation and innovation activities are often considered key factor to maintaining competitiveness on the global market. Innovation activities include all scientific, technological, organizational, financial and commercial steps whose purpose is to lead to the introduction of innovations into the market. " [5] One of the main goals of European policy is to encourage innovative activity in the European Union, with the aim of better positioning on the market. Studies have shown that those companies that implement

innovations are significantly ahead of the competition which can be seen in Table 1.

Table 1. Innovative companies in Europe [26]

Country	Proportion of innovative enterprises %
Germany	79,3
Luxembourg	68,1
Belgium	60,9
Portugal	60,3
Sweden	59,6
Ireland	59,5
Estonia	56,8
Netherland	56,7
Austria	56,5
Italy	56,3
Finland	56,2
Denmark	54,7
France	53,5
Czech	51,7
Slovenia	49,4
Cyprus	46,2
UK	44,3
Malta	41,5
Spain	41,4
Slovakia	35,6
Lithuania	34,5
Hungary	31,1
Romania	30,8
Latvia	29,9
Poland	28,1
Bulgaria	27,1
Island	63,8
Serbia	51,7
Turkey	51,4
Norway	43,5
CROATIA	42,4

Table 1 shows the proportion of innovative enterprises from 2008.-2010. in Europe. Among the European Union Member States, the highest shares of innovative enterprises were observed in Germany, Luxemburg and Belgium, while Bulgaria and the Czech Republic at the back. According to the table, in Germany is the largest share of enterprises, 79.3 % of all enterprises. Followed by Luxembourg, with a share of 68.1% in the total number of enterprises and Belgium with 60.9%. The smallest proportions of enterprises with innovative activities are in Bulgaria (27.1%), Poland (28.1%) and Latvia (29.9%).

In Croatia, the share of enterprises that have introduced innovations is 42.4%. This represents that Croatia has an average considering other European countries.

Innovative enterprises can be divided according to the type of innovation that is shown in next table.

Table 2. Innovative companies by the type of innovation [6]

Country	Product/ innovation process	Organizational/ marketing innovation
Germany	22,3	19,0
Luxembourg	11,9	26,6
Belgium	29,4	15,3
Portugal	20,5	23,2
Sweden	27,7	18,6
Ireland	22,1	21,4
Estonia	35,3	17,8
Netherland	32,9	16,9
Austria	22,3	22,2
Italy	22,5	28,2
Finland	28,2	17,4
Denmark	19,6	21,6
France	17,7	35,8
Czech	17,9	32,8
Slovenia	20,7	29,7
Cyprus	17,6	22,0
UK	19,8	26,3
Malta	21,5	26,5
Spain	31,2	29,4
Slovakia	18,3	20,9
Lithuania	19,6	34,4
Hungary	24,1	40,7
Romania	14,0	53,6
Latvia	21,6	44,0
Poland	24,2	42,5
Bulgaria	35,8	34,7
Island	26,3	10,9
Serbia	15,4	22,2
Turkey	17,3	31,5
Norway	31,5	22,5
CROATIA	22,0	24,9

Table 2 shows the proportion of innovative enterprises from 2008.-2010 by the type of innovation. Among the European Union Member States, according to introduction of new products / innovation process leads Bulgaria with 35.8%, Estonia with 35.3% and the Netherlands with 32.9%. The smallest proportions are in Luxembourg (11,9 %), Romanian (14,0 %). In Croatia, the share of enterprises that have introduced a new product / process innovation is 22.0%. The share of innovative companies by introducing organizational / marketing innovation is the highest in Romania (53.6%), Latvia (44.0%) and Hungary (40.7%). The lowest proportion is registered in Belgium (15.3%), Finland (17.4%) and Estonia (17.8%). In Croatia, the share of enterprises that introduced organizational / marketing innovation is 24.9%. Analysis of available data shows that companies in Croatia have to increase the level and quality of innovation. Only then will the Croatian companies

benefit from the innovations they felt that the economy based on innovation.
All new products are not successful. Many fail in its earliest stages, and some in the later stages. On the performance of the new products, or their failure act certain factors '' Factors of success of a new product can be:

- Specificity of the product-innovative and useful in meeting the needs of consumers, suitability target market,
- Product position and marketing mix-strong market position, moderate prices, convenient and functional packaging, quality and distribution of promotional program,
- Product development process-analyzing ideas before entering into a new phase, and do not skip any one stage during development,
- Marketing environment-the first product in the category of creates the image of the leader, mistake of competitor turn in your favor" [7]

Besides that the main reasons of failure are: a bit of good ideas for new products, divided and fragmented markets, various social and governmental restrictions (laws, culture, ecology), the high cost of developing new products and services, lack of capital in enterprises, speed development, shorter lifetime of products and services.
"Creativity is an activity that provides new, original products, whether in material or spiritual sphere, where these products cannot be attributed to imitate already existing products because of these very different. These new products, resulting from the creative process, should be better, more efficient and more rational meet individual and social needs of the previously existing product." [8]
Creative ideas range from company to company, but generally they can be classified into one of the following categories: technology, product, process and management.
Technological ideas are ideas that emphasize the invention that enhances the use of technology in the enterprise. Product ideas are ideas that emphasize the invention that brings a new product or service, or improve an existing product or service such as pricing, promotion of products on the market, distribution of products, packaging and advertising. Process ideas are ideas that emphasize the invention that will improve the production process. Control ideas are ideas that emphasize the invention, which is related to the way the organization. Precisely for this reason companies use a variety of methods of creativity shown in Table 3.

Table 3. Proportion of innovative companies by type of methods for stimulating creativity [6]

Country	Brainstorming	Financial incentives for employees to develop new ideas	Job rotation or staff	Non-financial incentives for employees	Training employees on how to develop new ideas or creativity
Belgium	42,0	8,7	16,2	10,1	18,9
Bulgaria	16,3	17,3	11,0	10,2	19,4
Czech	31,2	31,0	4,7	20,7	23,2
Estonia	37,6	14,6	17,4	16,0	11,9
Ireland	51,7	10,4	23,6	13,2	21,0
France	32,9	8,8	14,5	12,9	16,5
Italy	6,9	4,1	6,9	4,6	8,1
Cyprus	76,9	22,5	50,3	21,2	51,8
Lithuania	25,2	24,5	10,8	23,8	26,9
Luxembourg	72,2	22,2	35,4	32,4	46,1
Hungary	29,5	16,2	11,7	17,1	21,8
Malta	44,0	12,9	20,9	12,6	19,2
Netherland	37,6	5,5	10,6	8,7	13,2
Poland	31,8	26,6	15,1	15,2	21,2
Portugal	18,8	8,0	18,8	9,7	23,2
Romania	18,1	31,9	17,4	22,3	24,8
Slovenia	39,4	27,2	27,8	22,0	24,8
Slovakia	30,0	26,4	13,4	24,3	22,6
Finland	39,2	10,4	21,2	10,6	16,5
Norway	12,1	7,4	8,5	10,8	10,1
Turkey	26,9	20,8	23,4	24,8	28,2

Table 3. shows the proportion of companies by type of methods for stimulating creativity. The mentioned methods are: brainstorming, financial incentives for employees to develop new ideas, job rotation or staff, non-financial incentives for employees, training employees on how to develop new ideas or creativity. Most commonly used method of the above is brainstorming. Companies in more than half of the countries considered brainstorming to be the most beneficial method of stimulating creativity. Brainstorming is a group or individual creativity method by which efforts are made to find a conclusion for a specific problem, answering a question, by gathering a list of ideas spontaneously contributed by its members. The largest proportion of companies used brainstorming in Cyprus (76.9%), the highest proportion of financial incentives for employees to develop new ideas is used in Romania (31.9%), the largest proportion job rotation or staff is used in Cyprus (50.3%), the largest proportion of non-financial incentives for employees used in Luxembourg (32.4%), the largest proportion of training employees on how to develop new ideas or creativity is used again in Cyprus (51.8%).
Data for Croatia are presented in Table 4.

Table 4. Proportion of companies in the Republic of Croatia by type of methods for stimulating creativity [authors by 6]

Method	Companies' share %
Brainstorming	21,5
Financial incentives for employees	21,4
Job rotation or staff	25,4
Non-financial incentives for employees	20,8
Training employees on how to develop new ideas or creativity	24,4

Table 4. shows the proportion of companies in the Republic of Croatia by type of methods for stimulating creativity. All methods are equally close to each other. The largest proportion of companies (25.4%) use the job rotation of staff, and a method of training employees to develop creativity (24.4%) although they were relatively less often reported by innovative enterprises altogether as being highly successful.

5. Conclusion

Every company today feels the impact of globalization, migration, the progress of technology and the increasing market competition. The rapid progress of technology lead to the creation of new use-values, and thus to new products. At the same time product life will be shorter with a lower value in use. New product is more appreciated as a key component of sustainable development of many companies. For this reason, innovations are required more than ever. Innovations in enterprises represent a key value for the longevity of the business. For successful companies, innovation is part of their everyday life. Competition is a factor that raises the importance of innovation. Creating a new product better than its competitors, is the main factor in the development of enterprises. But innovation is not only important in business. Individuals are also innovators and adapting to market needs can create their own solutions. The greatest risk is not to innovate, because it guarantees the ultimate destruction of the enterprises, but also the bad positioning of the country. Croatia should invest more in innovation since it can improve its economic development.

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STATISTICAL ANALYSIS OF EMPLOYEE'S KNOWLEDGE ABOUT RISK MANAGEMENT – A COMPARISON OF THREE CENTRAL EASTERN EUROPEAN COUNTRIES

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Abstract

This paper deals with the knowledge about risk management. In particular, it examines employee's knowledge about handling risks in the construction sector. As part of his Ph.D. studies, the author conducted a survey with the help of a standardized questionnaire among personnel working in the construction business. In the survey, participants from three different Central Eastern European Countries took part and were compared to each other. The paper presents the results of the survey. After a short introduction first the examined matters and the purpose of the research are explained. This is followed by specifications of the circumstances of the survey and the composition of the sample. This part also includes a description of the standardized questionnaire that was used for the research. Results were analysed with statistical methods, such as standard deviation or correlation of different variables. As turnout, new insights are gained about employee's knowledge in terms of risk management and influencing factors that have an effect on people's know-how and skills. Respondents from Hungary, Austria and Romania and also some expatriates have been compared and interesting facts about these groups were found out and will be illuminated in this paper. The findings are finally assessed in form of a summary. The reader gains information about risk management in the construction industry and the utilization of statistical methods for data analysis.

Keywords:

Risk, Risk Management, Statistical Data Analysis, Construction Industry

1. Introduction

Crisis situations do not happen from one day to the next. There are signals that point to them and risks pose only the last phase of a long process. The question of why some companies fail to foresee their economic troubles is a legitimated one. Did they recognize the changes that took place in the company's environment but their decision-makers failed to see the significance? Or was the management not suited to properly handle the situation? It is often not the executive of the company, but rather a normal member of staff, standing at the bottom of the corporate hierarchy, that first encounters the risk factor and attempts to manage it. However, these persons cannot be expected to have risk management skills and knowledge. They often do not have theoretical knowledge and sometimes even their practical experience is lacking.

The knowledge of business companies' staff about risk management is influenced by several variables, with the influence being of different levels. It is therefore not equal for all employees. For a company it may be advantageous to know these variables in order to find a suitable employee for each task or to entrust each employee with such tasks that they can solve for sure. By deliberately changing some variables, the company has the opportunity to improve risk management. It is therefore interesting to research about the influence of different variables on the knowledge of employees.

2. Theoretical background

Precondition for dealing with risks is at first an understanding of what the term risk means at all. In the general perception risk has a negative connotation. Several authors connect risk with a target hazard risk or the deviation from a pre-determined target. *Neubürger* [1] defines risk as *"positive difference between the expected and actual target achievement."* Accordingly, a chance means the negative difference between the expected and the realized level of target achievement. However, another definition of risk shall be mentioned, which was worked out by *Ehrmann* [2]. His explanation is even suitable to be used as valid for the scope of this article as definition of the term risk. According to the author risks are:

- connected to decisions,
- originate from the uncertainty relating to the assumptions during decision-making,
- mean a danger or hazard.

In addition to the term risk, risk management must be illuminated as well. According to *Eichler/Bungartz* [3] there is a very comprehensive, but at the same time also very compact definition of the process of risk management, which, for reasons of comprehensiveness and conciseness appears to be suitable to determine the process of risk management for the scope of this article: *"Enterprise-wide risk management is understood as the process of strategy formulation, the enterprise-wide identification of significant risks and opportunities, managing these risks, taking into account the risk appetite of the company, to ensure the achievement of corporate goals, done by the supervisory board, the upper management, the operational management and the employees." Haller* [4] places significant risks in the center of his definition of risk management, which is oriented in his view to:

- In all management activities and in all aspects of leadership to recognize and assess the significant risk better,
- To tackle as important considered risks with suitable instruments and procedures,
- To pull general leadership and organizational consequences in terms of risk management.

3. The aim of the research and expected results

In the center of this article is a comparison of different countries with regard to their employees in the construction industry. To be found out is the influence of this variable on the knowledge of the employees. The research is carried out in three different countries, so it lends itself to check whether the results differ depending on the country. Subject of the research are the countries Hungary, Austria and Romania. Of course, there are differences between these countries, but the knowledge of the employees is in the foreground. Since the activities of employees are the same in all countries and construction projects are handled in a similar manner, it could be assumed that the knowledge of the employees about risk management is not significantly different compared to each other. Accordingly, during the research process initially it is assumed that there is no correlation between the country of work and the knowledge about risk management.

Hypothesis: Knowledge of risk management on the one hand and the country of labor exercise on the other hand are two independent variables.

4. The applied research method

Data-collection by questionnaire is a very common instrument of scientific research and offers several advantages. In research using a questionnaire, compared to qualitative research, done by for example conducting interviews with comparatively few respondents, other targets are in focus. On the one hand, a large number of people can easily be interviewed and on the other hand the information obtained can be statistically analysed and conclusions with respect to the research subject can be drawn. To achieve this goal, the use of a standardized questionnaire is recommended, in which all questions were formulated uniformly and the answer choices are already predetermined.
A survey among a large number of employees in the construction industry with the help of a questionnaire forms one of the pillars of the author´s empirical research. For a detailed review of the hypothesis, a part of the questionnaire contains questions with the help of which the participants' knowledge can be measured. Through the classification of respondents to groups of attributes, in this particular case the countries of work, and the statistical analysis of the responses of these groups, for example through the analysis of variance, inferences are to be drawn on the impact of the variable.

5. Participants in the survey

All persons participating in the survey were at the time of the survey employees of various construction companies. Respondents were working on construction projects, in the administration of their companies or in executive positions. In the interest of the fact that the results of the survey can be obtained from a wide amount of data, the survey was conducted in three different countries: Austria, Hungary and Romania. In order to facilitate the respondents in the various countries responding to the questionnaire, it was created in three different languages, so that each participant could complete the questionnaire in their own native language. This measure also increases the reliability of the results, since such errors can be excluded, which arise due to any misunderstandings. The survey was conducted in spring 2011.
The questionnaire was completed by a total of 209 participants who were distributed among the three countries mentioned. The largest proportion were the Austrian respondents, participants from Hungary and Romania were fewer in number. The proportion of employees from these two countries is smaller. Expatriates, employees who, due to a letter of assignment, carry out their duties outside their home country, formed a separate group. Their group is very small, but is listed separately because of their special status. The distribution of respondents can be found in *Table 1*:

Table 1. Distribution of the variable „Country of Work", Source: author's own work

Country of Work	Frequency	Percent %
Austria	115	55,0
Hungary	48	23,0
Romania	37	17,7
Expatriates	9	4,3
Total	209	100,0

6. The questionnaire

In order to limit the effort to evaluate all questionnaires differently, it appeared advisable to have the questions answered in multiple-choice system. Through this approach, space for individual answers to the questions was given and the questionnaire could still be standardized and then analyzed by statistical means. Taking into account the advises of *Babbie* [5] for structuring a questionnaire, the questionnaire was divided into the following parts:

a) Knowledge about risk management
- Questions about risk management in general (8 questions)
- Questions about risk management in business companies (8 questions)
- Questions about risk management on construction projects (8 questions)

b) Questions regarding personal data (4 questions)

The questionnaire included a total of 66 questions and also some other topics regarding risk management. The other sections were mainly about reasons for risky projects and risk awareness. The results of these parts of the questionnaire are not listed here since they are very specific and would exceed the scope of this article. In order to explore the knowledge of the employees interviewed about risk management, this part of the questionnaire was divided into three blocks, each containing eight assertions. The first block contained general statements with regard to risk management, in the second block statements about the company for which the respondents work could be found. Assertions about the handling of risks especially on construction projects formed the third group. Every question appeared in the form of a *"right or wrong"* statement, which was to be answered by the respondents. If the respondent did not know the right solution, they could also check the response *"I'm not sure",* meaning that questions were only answered, if the respondent knew the answer. Of course, there was only one correct answer for each question. Half of the assertions in each block was right, the other half was wrong. During the process of analysis every correctly answered question was awarded with one point, the answer *"I'm not sure"* was considered wrong. Through different distributions of correct and incorrect responses within the three blocks, conclusions could be drawn about the intensity of the knowledge of employees in the three areas of risk management.

7. The process of analysis of questionnaires

Multiplying the number of questions per questionnaire with the number of participants in the survey, there were about 13,800 records that had to be evaluated and were incorporated into the survey results. To process this large number of data on a professional level and be able to analyze it using statistical tools, the evaluation of the data set was operated with the help of *SPSS Statistics*, a software by the U.S. company IBM. According to *Hunyadi/Mundruczó/Vita* [6] *"The SPSS software package was developed in the interest of enabling a very flexible and effective computer-based implementation of social-scientific analysis."* Most of the evaluations were carried out by the method of analysis of variance (ANOVA = ANalysis Of VAriance), which analyses the effect of independent variables on dependent variables. The method is based on the calculation of variances and according to *Hajdu* [7] has the advantage that *"the variance usually not separately, but in the implementation of comparisons makes sense"*, so it is suitable, for example, for testing hypotheses.

Among the completed questionnaires there were also such that were not filled completely or partly faulty. From the total of 209 questionnaires, all questions were answered in 137 cases, in all other questionnaires a few questions, in most cases only one single question, remained unanswered. Regardless of unanswered questions, however, these questionnaires are part of the evaluation, only the non-responses were disregarded. When in a questionnaire for example two questions were not answered, then all other questions are included in the evaluation. With respect to the two questions, the total number of elements in each case has decreased by one. In order not to distort the results, the missing data has not been replaced by average values or incorporated in the analysis by using any other different method.

8a. Results of the survey: Knowledge about risk management

First, it is worthwhile to consider the answers as a whole. Already the two extreme values are interesting. The achieved minimum score is zero, so at least one of the respondents has not given a single correct answer. The maximum score however is 20 correct answers. This means that out of the theoretically possible 24 points, the participant with the most correct answers just was able to answer 83.3% of the questions correctly. These two extreme values, which were determined

from all questionnaires, generate the first impression that the knowledge of the respondents can be further improved. This impression is enhanced when one considers the average values. All respondents answered on average 11.6 questions correctly. From a number of 24 questions, this value is even slightly below the threshold of 50%. This value is backed up by the standard deviation. The standard deviation or variance according to *Hunyadi/Mundruczó/Vita* [6] *"is the average square of the deviations from the average. Accordingly, it indicates by how much the measured values deviate from the average arithmetical average. The unit is always the same as that of the original data."* Standard deviation was 4 correct answers, which means that the respondents answered on average between 7.6 (31.7%) and 15.6 (65.0%) of 24 questions correctly. As shown in *Table 2*, the participants, on average, had only so much knowledge about risk management that they could answer only about half of all questions with a standard deviation of four correct answers.

Table 2. Statistical figures regarding the knowledge about risk management, Source: author's own work

Correctly answered questions	N
Minimum	0,00
Maximum	20,00
Mean	11,6054
Standard Deviation	3,9824

8b. Results of the survey: Influence of the variable „Country of Work"

In the next step, the relationship between the country in which the respondent works, and his knowledge about risk management was studied. **The hypothesis initially assumed that these are two independent variables. However, the results of the survey have not confirmed the hypothesis.** In all cases, a connection between the country of work and the knowledge about risk management exists. This knowledge is highest with the seconded employees. They answered on average 13.5 questions correctly, which corresponds to slightly more than 56%. This is followed with already more than one point distance by the Austrian staff, who could on average answer 12.4 questions correctly, which is slightly above the threshold of 50%. The Hungarian employees reached 11.0 correct answers given, after all, still almost half of the possible points. The Romanian employees are cut off in fourth place, with an average of 9.6 correct answers they reached only a quota of 40%. The detailed results are shown in *Table 3*.

Table 3. Mean and standard deviation depending on „Country of Work", Source: author's own work

Country of Work	N	Mean	Standard Deviation
Austria	114	12,37	4,3642
Hungary	48	11,00	4,3621
Romania	37	9,58	4,1058
Expatriates	9	13,50	4,0838

This finding is supported by the results regarding the knowledge in the three blocks. Again, the expatriates reached the highest results of all, except for one block. Furthermore, in each block, the results in Austria are higher than those in Hungary and these are in turn higher than the results in Romania. The detailed numbers can be found in *Table 4*.

Table 4. Results in the three blocks of knowledge depending on „Country of Work", Source: author's own work

Country of Work	General Knowledge	Company Knowledge	Constr. Knowledge
Austria	3,53	3,08	5,75
Hungary	3,23	2,51	5,26
Romania	2,97	1,97	4,61
Expatriates	3,22	3,25	6,44

Furthermore, as part of the analysis it was tested whether links to other variables exist. In case of two groups, according to *Hunyadi/Mundruczó/Vita* [6] the Mann-Whitney test is used. For comparing at least three samples to each other, the Kruskal-Wallis test can be utilized. Both work as a non-parametric statistical test that do not assume a given probability distribution and examine differences in the median of each group. The chi-square provides information on the distribution of the values, dF on the degree of freedom and the significance level on the probability of error. Only such links are shown below in which the significance level has a maximum of 5%. Subsequently, the groups can be compared to each other based on the respective group average (mean rank).

The review with the Kruskal-Wallis test delivered further insight into relationships of the variable country of work with other influence factors. Thus, it could be an explanation for the weak performance of the Romanian respondents that the rules on risk management are the least known among them. At the same time, they are the group in which most respondents agree that a briefing or a training would be useful. The second group, which stated that a briefing or a training would be

useful, are the expatriates. This is an interesting finding, because with them the knowledge about risk management is the highest. At the same time, their awareness of the regulations is low, because, according to the respondents, they are partially disordered and difficult to find. In case of the expatriates, the proportion of decisions that are made to the best of knowledge but not necessarily under application of a rule is the highest. Also on highest level is the proactive course of action that is not limited to the reporting of risks, but also includes handling them without being asked. The survey has thus shown that the expatriates are a group of employees who act very proactively and have a very high knowledge, but this is more based on experiences and less on applying rules. The regulations are not always known and there is a need for help with tools. Detailed results are shown in Table 5.

Table 5. „Country of Work": Interdependencies with other variables, Source: author's own work

Kruskal Wallis Test	Know-ledge about risk managem ent	Question 20 I think a briefing or training would be useful.	Question 25 The regulations are known.
Chi-Square	16,0158	12,3577	10,4430
df	3	3	3
Asymp. Sig.	0,001	0,006	0,015
Austria	103,69	91,96	112,51
Hungary	85,90	110,77	94,15
Romania	63,37	124,55	81,12
Expatriates	117,25	121,83	86,78
Kruskal Wallis Test	Question 30 It is difficult to know all the regulations because they are accessible in different places.	Question 34 I make many decisions to the best of knowledge because there is no regulation.	Question 35 I limit myself to report identified risks, without instruction I do not do anything against it.
Chi-Square	13,1249	14,6673	19,4812
df	3	3	3
Asymp. Sig.	0,004	0,002	0,000
Austria	108,94	94,79	95,69
Hungary	100,04	117,66	129,72
Romania	71,95	85,86	92,24
Expatriates	118,89	147,22	58,83

The Hungarian respondents usually occupy one of the central ranks, with the exception of the already mentioned proactive action. Here they are by far in the last place, identified risks are reported but nothing is done without instruction, what is characteristic for a reactive behavior.

8c. Results of the survey: Correlation of different variables

Interesting insights into the relationship between different variables can be obtained through calculation of correlation of the variables. *Hunyadi/Mundruczó/Vita* [6] state, that *"… it must be out-raised that neither the results of the correlation nor the regression analysis can be automatically interpreted as a causal relationship. Both methods give information only about the presence, intensity and direction of the connection of two variables."* Correlation may be positive, then the variables move in the same direction, or it can be negative, then the variables move in opposite direction. A value close to zero indicates that there is no correlation, a value close to 1 or -1 indicates a very strong correlation. Taking these conditions as given it has been examined whether correlation occurs between the following criteria:

- Knowledge about risk management in general
- Knowledge about risk management in business companies
- Knowledge about risk management on construction projects
- Knowledge about risk management in total
- Country of work

Taking into account the complete questionnaire, a sum of 52 attributes arises, of which each was tested with all others. In total 1.378 correlation values were gained and involved into the analysis. The values obtained can be divided into five groups, according to their size and the size of the confidence interval, which describes the accuracy of the calculation:

- No or little correlation (values up to +- 0,14)
- Significant correlation with a confidence interval of 5% (Values from +- 0,14 to +- 0,185)
- Significant correlation with a confidence interval of 1%, with values that are to small to derive theoretical relationships
  (Values from +- 0,185 to +- 0,4)
- Significant correlation with a confidence interval of 1%, with values that are large enough to derive theoretical relationships, the contents of the correlation is, however, not definable
  (Values > 0,4 or < -0,4)
- Significant correlation with a confidence interval of 1%, with values that are large enough to derive theoretical relationships and the contents of the correlation is definable
  (Values > 0,4 or < -0,4)

The study therefore assumes that several conditions must be met in order to recognize a relationship between two variables. With a confidence interval of 1%, a value of 0.4 or higher must be achieved. Only in case of the completion of both criteria one can assume that both in terms of the size of the confidence interval, as well as in the level of correlation sufficient security is given in order to define the content of the correlation in a meaningful way. Of all the values, this was given in 34 cases. Out of these, however, the contents of the correlation could be defined only for a total of 6 values, which means that a sense of connection between the two variables can be established. Half of them included the variable country of work:

- There is correlation between the country of work and the knowledge about risk management on construction projects (Value: 0,833)
- There is correlation between the country of work and the knowledge about risk management in business companies (Value: 0,755)
- There is correlation between the country of work and the awareness of the regulations regarding risk management (Value: 0,423)

9. Conclusion

The employees' knowledge about risk management is influenced by several variables. Depending on the variable, this influence turns out differently. The influence of different variables on employees' knowledge could be explored with the help of the questionnaire. The total of all respondents has been divided into subgroups, depending on in which country they exercise their working activity. Subsequently it could then be researched whether the dependent variable, the knowledge of respondents, performs significant differences in the various groups. This was possible because the standardized survey was carried out in three different countries: in Austria, Hungary and Romania. In the course of the survey, these three countries were supplemented with the category of expatriates, respondents who fulfil their work outside their home country and therefore cannot be clearly assigned to one country. The results of the survey have not confirmed the hypothesis. In all cases, a connection between the country of the work and the respondents' knowledge about risk management was found.
The knowledge was the highest with the seconded employees. They were able to answer correctly on average slightly more than 56% of the questions. The Austrian respondents who were on average able to answer 52% of questions correctly followed them. The Hungarian participants reached with 46% correct answers given, after all, still almost half of the possible points. The respondents from Romania were slightly cut off in the fourth place, they reached an average rate of 40%. This finding was supported by the results in the three blocks of knowledge. Here, too, with one exception, the expatriates reached the highest results of all. Furthermore, the results for each block in Austria were higher than those in Hungary and these in turn were higher than the results in Romania.
Through the statistical analysis, further findings could still be detected. Among the Romanian respondents, the regulations on risk management were the least well known. At the same time, they were the group, which stated mostly that a briefing or a training would be useful. The second group, which agrees that a briefing or a training would be useful, were the expatriates. This is an interesting finding, because with them the knowledge about risk management was the highest. At the same time, the awareness of the regulations was low. For expatriates, the proportion of decisions that are made to the best of knowledge but not necessarily under application of a rule was at its highest. Also on highest level is the proactive course of action that is not limited to the reporting of risks, but also includes handling them without being asked.

1. Thesis: The survey has shown that the expatriates are a group of employees who act very proactively and have a very high knowledge about risk management. However, this is more based on experiences and less on applying rules.

The influence of the country of work on the knowledge about risk management could also be researched with the calculation of correlations. Correlation could be found between the land of work and the blocks of knowledge about risk management. The correlation between the country of work and the knowledge about risk management on construction projects was 0.83, the correlation between the country and the knowledge about risk management in business companies was 0.76. Both of these are very high values, as the maximum correlation may only take a value of one. A direct correlation between the two variables could thus be clearly demonstrated.

2. Thesis: There is a connection between the knowledge about risk management on the one hand and the country of work on the other hand.

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THE IMPORTANCE OF INVESTING IN EDUCATION OF HUMAN RESOURCES IN MANAGEMENT

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Abstract
Education is needed so that the organization could accomplish the goals of the enterprise. Apart from managing and education of people, there are other key concepts of work that are being worked on, and those are: motivation of the workers, investing in human resources, team-work, organizational study, emotional intelligence in management and it`s development, career and people management. Allows these activities are part of the organization and its functions which serve for development and the successful progress of the company. The practical example of investing in education of human resources was analyzed at the end of the paper.

Keywords:
Human resources, education, management

1. Introduction

Education of human resources is one of the most important functions of the organization. Human resources are developed in the organization in order to help company to achieve better results. Implementation of education in the organization is a complex activity that requires a lot of effort and time. Through the work it will pass through the different segments of education and human resources.

2. Management

„Management is the process of reaching organizational goals by working with and through people and other organizational resources. Management has the following 3 characteristics:

1. It is a process or series of continuing and related activities.
2. It involves and concentrates on reaching organizational goals.
3. It reaches these goals by working with and through people and other organizational resources.“ [1]

The five management functions that make up the management process are planning, organizing, controlling, human resources management and leading.

The purpose of a paper is to analyze the importance of investing in education of human resource in management.

3. Learning organization

Knowledge is a mix of experiences, opinions and values of the individual. It is stored in the mind of the intellectual.

The types of knowledge are explicit and implicit knowledge.

Explicit knowledge is knowledge that the knower can make explicit by means of a verbal statement. Implicit knowledge can then be defined simply as knowledge that is not explicit. [2] Explicit knowledge enables faster transmission of information. It appears through the various means such as books, manuals, documents and audio recordings.

Implicit (tacit) knowledge encompasses a variety of phenomena, such as the ability to recognize something even though one cannot describe in context-independent terms how one recognizes it. It also includes the holistic diagnostic skills that an experienced and humane psychologist or psychiatrist brings to a clinical encounter.

“Tacit knowledge is a subtle level of understanding often difficult to put into words, a trained recognition and perception, a good feeling for the technology; wholly embodied in the individual, rooted in practice and experience, expressed through skillful execution, and transmitted by apprenticeship and training through watching and doing forms of learning.” [3]

Learning organization is organization that provides education for all of its members and that is constantly changing and adapting.

Features of such organization are:

- It supports managers and other employees to improve knowledge and skills by continuous learning.
- It supports employees to ask stimulating learning objectives.
- It supports managers to plan, to do, to check and to act learning activities.
- It tolerates some mistakes if employees can learn from them.
- It ensures employees new experiences from which they can learn.

Organizational learning from the perspective of the cognitive, social networks is the process of thinking with participation of all levels of the organization that include the collection of information both from

the outside, and from the internal environment. This information is then filtered through a collective process of finding meaning, which results in sharing interpretations that may be employed in order to launch actions that lead to changes in the behavior of organization.
All people don't learn in the same way and each person doesn't take the same amount of time to learn something. Each person has its own learning style. There are four different learning styles:

- Activists – such persons haven't problems to surrender to new experiences.
- Thinkers – such persons observe new experiences. First, they collect information and then make conclusions.
- Theorists – such persons apply their observations in the form of logical theories.
- Pragmatists – such persons try out new ideas, approaches and concepts to test how they work in practice. [4, p. 152]

4. The educational process in the organization

Today, education is becoming one of the most important forms of management and human resource development. Modern companies more and more time and resources spend on training and education of their personnel. In the 21st century managers realize the important of constantly investments in training of its personnel and it's become one of the efficient ways to achieve competitive advantage in the market. This knowledge is the result of major changes in the company which lead to the achievement of objectives and market competitiveness. With the fast development of global economics, the environment of modern enterprises has become more and more changing. The changes of enterprise environment contain two aspects of meanings, one refers to the changes of the external competitive environment, and the other is the changes of the internal developing environment, such as the reconstruction of organization structure. [5] The changing enterprise environment brings new challenges for human resources management.
The reasons for investing in education are numerous, and some of them are:

- Changes in technology that allow the obsolescence of knowledge and that requires new learning and education.
- Increase in complexity, turbulence and uncertainty of the business environment that requires more and different knowledge, and puts people and their development in the forefront.
- Modern business requires new skills such as conflict management, time management and new forms of efficiency.

The education in the organization brings new effects that affect to the organization as a whole and to its success in the work. Some of the effects are:

- Increase the knowledge of employees about the competition.
- Provide to employees the knowledge and skills needed to work with new technologies such as the computer.
- Assist the employees with team work and thus contribute to the quality of the company.
- Provide an organizational culture that emphasizes creativity and innovation.
- Pursue the safety of employees in order to develop their knowledge.
- Provide and prepare employees to cooperate.

Organizational development is usually defined as the application of behavioral science techniques to improve organization's health and success using its ability to successfully cope with the surrounding changes. [6, p. 777] Managers play a major role in organizational development. A large part of organizational development depends on them, their knowledge, skills and abilities.
Constantly learning, generally become a crucial process for the innovation and development of organization and management. Training and development is the process of gaining new skills and knowledge that are necessary for the future of the organization and its competitive development. Development of employees generally refers to the training and development of employees to be able to do the required tasks. [6, p. *777, 778*]

5. Emotional intelligence

"Emotions are at the center of capabilities for living. They lead to reflections, value systems and human species survival." [7, p. 300]
Emotional intelligence is the ability of people to recognize their emotions and emotions of others to make the system function better and prospered. It serves in order to motivate employees its own or others' emotions. "Emotional intelligence is manifested in the individual's self-awareness, self-motivation, managing and adapting it in building relationship." [8, p. 328]
The aim of emotional intelligence is to enable people progress and improvement of their behavior that are based on their skills as motivating themselves and others, and persisting despite difficulties and frustrations. It is a process that allows people management using the emotions. Emotional intelligence allows people to restrain their emotions and impulsivity. Persons who are strong enough can control its emotions and mood. Emotional intelligence is a new concept and it has been proven that it can learn and adapt. Many people use their emotional intelligence as motivation and to be more successful in the

workplace. Emotional intelligence can be equally influential, and sometimes more influential than IQ. Crucial emotional abilities can learn and improve. [7, p. 34]
Academic intelligence can't prepare someone for crises or problems that occur during the life. The high IQ is no guarantee of success or happiness of someone's life. Today's culture is obsessed with the academic skills while emotional intelligence is neglected, and it determines the ability of man. "The emotional life is an area where someone, just as in math or reading, could be more or less successful and requires a unique set of capabilities." [7, p. 36]
Emotional intelligence is an important for daily life, but also in management. Emotional mastery at the workplace is very important for every member of the organization because if you govern them, you can also govern the situation. People find it difficult to govern emotions in unexpected situations because many do not know how to hide an immediate response to any dissatisfaction or satisfaction. Top mastery of emotional aspect is very difficult because of the skills necessary to acquire at times when people are usually least able to receive new information and learn new habits - reacting when they are upset. [7, p. 267]

6. Use of emotional intelligence in managerial work

Management has a goal and task to successfully manage the company and employees. Every manager must have the ability and skills to manage people and direct them toward achieving the goals. The successful leader must be familiar with the people and their potential to take advantage of them at the best way. Some studies have shown that managers with a high level of emotional intelligence will be more successful, because it is likely to create an organizational culture filled with confidence, learning, sharing information and desirable forms of risk-taking. [8, p. 328] At the management it is very important to motivate yourself and the people around you. Knowledge of own emotions is very important in order to know how to control in an emergency. "Recognize your own feelings are the key of emotional intelligence." [7, p. 44]
Emotion management is an ability that allows people to master themselves and their own behavior, self motivation and creativity. Every manager should have the ability to recognize the emotions of others. Manager's task is to get know his employees and their personalities in order to know how to lead and motivate them and improve human resources in an organization. This ability is a basic skill for dealing with people.

7. Education and human resources management on the example of the company "OBI stores"

The implementation of education organization is a very complex activity. Education is conducted within human resources management. In practice, the education of employees occurs several different terms such as: learning, training, education and the development. Learning is the acquisition of knowledge and the skills that result in the permanent change of behavior. Training is practice of some intellectual activity. Education means the dissemination of knowledge, skills and the abilities that a person qualified for self-determination. [6, p. 721]
The goal of any organization is training employees in order to accomplish their full potential. Education becomes the obligation of all members of the organization in order to spread knowledge and the progress, and in that way organizations kept their competitiveness in the market. So the OBI stores enable their employees to develop and to educate in order to be successful in communicating with customers and sales. OBI is realized the potential of its employees in order to create a habit of education and training.
"Privately owned by the Tengelmann Group OBI was founded in 1970. As the undisputed market leader in the German DIY retail industry, OBI is the driving force which propels the entire trade. Since 1993 the company has used its powerful position within the home market to press ahead with its expansion internationally. OBI's market share rises continuously, improving its pole position in the market permanently. The target of OBI is indisputable market leadership in sales and market share, product and service innovation, and in the realization of concepts and store formats in many international markets. Building up a long-sustainable business model and growth will be the driving force of OBI's future success. Currently, the company operates in 12 central and eastern European countries more than 570 stores, thereof more than 330 in Germany. Today the Group has more than 42.000 employees." [9]
OBI was present for 7 years in Croatia. Headquarters was located in Zagreb, and shopping centers were in Slavonski Brod, Sisak and Varazdin. OBI Croatia employed 180 workers. It is a company that through the years of work progress and develop. It gained the trust of customers, and each year educates its employees and allows them progress and security. OBI closed its stores in Croatia in 2014.
Following the recruitment and selection of staff, in OBI begins the process of schooling. First length of training depends on the position and responsibilities of employees and may take from two to six months before the accession of the master workspace. In addition to the initial training

are being continuously implemented education related to the trading software' program and the changes in the mode of operations in relation with the provision of audit.

Table 1. Countries where OBI operates [9]

Country	Open since	Number of stores
Germany	1970	346
Italy	1991	52
Austria	1996	32
Hungary	1994	28
Czech Republic	1995	29
Poland	1997	46
Slovenia	1998	7
Switzerland	1999	10
Bosnia-Herzegovina	2003	1
Russia	2003	22
Croatia	2007	0
Romania	2008	7

Personnel should be also instructed in the range of goods that offers customers and need to have knowledge about them. So OBI organizes schooling that performs suppliers of goods offered in the store. To make all the employees able to offer the same quality of service, they are required to participate in the training courses on topics: fundamentals of sales, communications, crisis management, dealing with difficult customers, and more. These educational programs are intended for new but also the old workers with the purpose that new employees master proven skills and old employees remind on the skills they already possess. Education is intended for all employees regardless of their legal position. This internal education is divided into five modules followed by a written exam, which primarily serves as a reminder of already attended modules.
Also, employees are enabled to anonymously evaluate the quality of transferred information, the quality of teachers and to give advice on how to improve the quality of the materials of modules.
OBI also offers individual education by invitation of tenders on which may apply any interested employee. One of individual education and training was intended for women as senior-level executives within the company OBI.

8. Conclusion

What say, except that education is one of the most important things in life, whether in business or private. Human resources are important for the organization, because if organization invests in them, they will achieve success. So, education of human resources is important for the company in order to progress the organization and operated successfully. Managing and motivating human resources in the organization leads to success. So, managers in the organization have the task to direct, manage, motivate and educate their employees. Using emotional intelligence managers educate to understand the people and their needs and emotions.
Today, if the organization want to invest in people and to make people more motivated to work, it is necessary to know people' needs and desires.
OBI stores served as an example of the education of human resources. Their motto is that the education of people leads to success. OBI stores invest and motivate their employees in order to better perform tasks and carry with an emergency.
For the conclusion of this paper, it can be said that education is the key to the success of human resources in management and survival in a broad and demanding market.

Acknowledgement

This paper grew out of final paper.

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POSSIBILITIES OF DETERMINING THE VALUE OF URBAN GREEN AREAS

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Abstract
Urban green spaces are public goods that are used in unrestricted or restricted way. Establishing and maintaining source are public funds. They represent value undoubtedly. The amount of this value can be tested in several ways. Criterion would be the cost of their installation, maintenance cost. We can specify the value of the plants. The social value can be estimated based on the user's opinions.

Keywords:
public goods, assessment, urban green spaces.

1. Introduction

Public goods are an important category of economics. One of these is the free goods that are created by nature. The others created by man. They are free to use for everyone, but at the cost of incurred expenses of the society. In order manage them well it is necessary to determine the appropriate value. The urban green spaces are important to the inhabitants of the larger settlements. Determining the value of these different methods can be employed.
The importance of urban green areas shows that the WHO has formulated a recommendation. Be at least 9 square meters of green space per capita in urban areas. This is not always achieved, see Figure 1. [6]

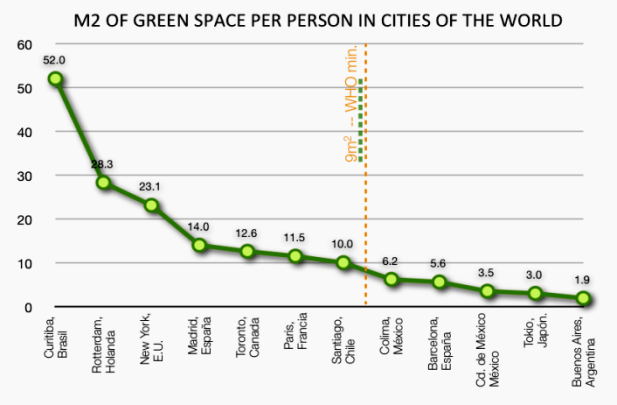

Figure 1. Green space in some cities (m2/capita)

2. Method

Key elements of the green areas are the trees. Specify the value of the trees have been carried out over a hundred years. The value can be specified in several ways.
The alternative value is the cost of installation and care of the trees. The value of the tree may be the value of the industrial goods value or the value of firewood. The real value-added items such as trees established during the buying and selling of real estate. The trees can increase up to 5-20% value of the property. [2]
The trees transactions veins law should also be noted. It is essential to know the value of trees in litigation. Frequent cases are traffic accidents, utilities or damage resulting from the construction of buildings, land expropriation, intentional damage assessment.
Environmental value of trees is releasing oxygen, sequestrating carbon-dioxide; increasing the humidity, reducing noise.
Social value of the trees, leave the rest and relaxation that create the conditions for private gardens and public areas.
The circumference method is one of the oldest methods. The tree is measured at breast height. Each inch of a circle the size is worth of $ 5 considered in the USA. G. Stone has developed a different method in Massachusetts Agricultural College. He calculated the value of the wood of the tree at breast height measured from the cross-section. The value of a square inch size up to 0.75 cents considered.
The Felt method and the Felt-Spicer method are sophisticated, they take into account the species of tree, the location and state of health.
The ITSC method. The National Forestry Company adopted a new method at the International Shade Tree Conference in 1951.[2]

The value of individual tree = default value x species multiplier x condition factor.

The Stone method makes the default value, 1,5$/square inch (updated value). The species multiplier depend on geographic fit of tree, between 100 and 20%. The condition factor has three parts as the tree age, location and state of health.

The Hungarian methods based on Romuald-method (Olaczek Romuald a Polish researcher). This complex method integrates five components. The first is the amount spent on tree care, the second the social value of ecological functions, the third social value of health functions, the fourth the social value of the aesthetic features and the fifth is historical value of the famous trees. The valuation is based on the principle of replacing the function of aged wood. The value of the old wood is the cost of planting young trees which are functionally able to replace it.

The method of Hungarian researcher Radó is based on measure that trees can produce oxygen, absorb carbon dioxide, water evaporates, absorb dust. All these functions are proportional to the leaf surface. His measurements showed that a unit of crown volume (1 m^3) includes four times leaf area (4 m^2). [1] The increase in crown volume can be described by an exponential function. The method can no longer count foliage growth of tree over the age of 70. The crown of a standard nursery sapling is a quarter of a cubic meter. The value of the tree equals the seedling nursery price multiplied by four times the volume of the crown.

Hungarian researcher Párkányi developed the Radó-method. She classified the urban trees under a crown shape, created nine classes. Instead of the exponential function she applied the logistic function.

$$y = \frac{A}{1 + ae^{bx}} \qquad (1)$$

A = cubic meters of foliage, full developed tree
a, b = parameters, depend on species
x = number of years.

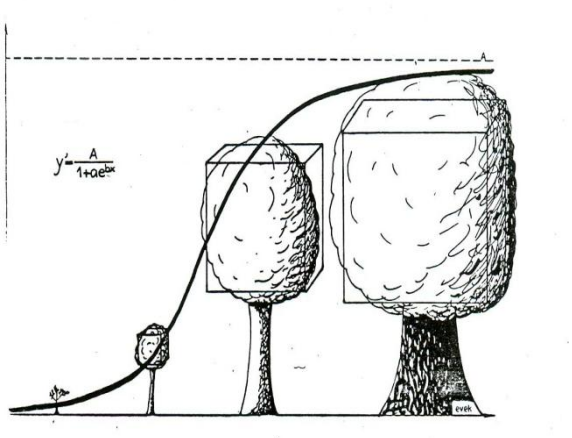

Figure 2. Tree valuation, function can be described on the basis of life cycle

Párkányi developed a computer program for calculating the value of the tree used and tabulated the index numbers of simple multiplication calculations. She defines the value of the tree so that the index number is multiplied with the nursery price.

It is possible to define the value of other plants in urban green areas also. By the method Radó or Párkányi we can establish the unit value of 1 square meter of the leaf area. We can calculate the value of bushes, lawn, hedges and flower-beds on the basis unit value.

The value of built (not live) elements can be calculated by the establishment costs. For determination of the present value of these components we have to take the amortized cost into account.

Total value of a green area includes the amount of values built elements and the values of plants. This is a bottom-up traditional economic calculation.

There is a new methodological option to estimate the value of the green areas, such as the green areas of social value. The calculation is based on the following assumption. The value of green areas equals the money that residents are willing to spend to visit it. It is a valuation possibility of public gardens and parks. For significant application of the method a lot of data collection is required. It is necessary that the sample is representative and is sufficiently large. We have to be able to tell how much time and cost spent on visiting the green areas. The annual number of visits multiplied by the costs per visit makes the value of the green areas.

Panduro and Veie presented an urban green area classification in 2013. During the classification the accessibility of area, quality of care and way of use of the neighboring area are important. By using hedonic housing evaluation method, it was found that the easy-to-access and high standard maintenance significantly affect green areas for the implicit housing prices.[4]

Improvements of green areas require additional methods, economic evaluations. The decision-makers know the economic calculations which in life proven. Vandermeulen and some authors have been applied the net present value calculations (NPV) when examining a green infrastructure development, it is a known pointer at the investment evaluation. [5] Other similar developments are supported by cost-benefit analysis. [5]

3. Results

We examined the extent of green space per person in some major Hungarian cities. Each met the WHO recommendation. The green area in Kecskemét is four times more than the recommended value, and three times more than in the Hungarian capital.

During our investigation we studie more than one green areas in Kecskemét. We completed evaluation of 14 trees in one of these areas. Due

to the missing installation documentation we have to determine the age of the trees by measurement. We measured at a height of 1 meter the circumference was calculated based on the diameter of tree. We estimated the tree age based on the diameter of tree and the species of tree.

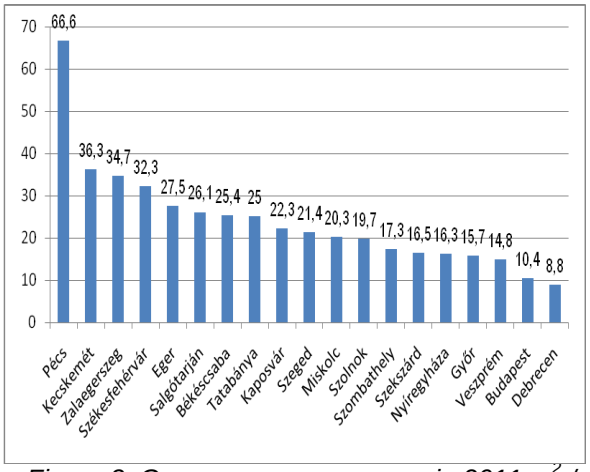

Figure 3. Green space per person in 2011 m^2 / person
(CSO data, private ed.)

Application of the methods of a selected high ash tree (Fraxinus excelsior) is presented as an example. The high ash circumference (212 cm, 84 inch), diameter (26,78 inch, 67,48 cm) cross section (3576 cm^2, 563,2 square inch).
Accordance with the Stone method was set the value of tree, the tree of 10 $ /square inches and cross-sectional view of the 563,2 square inches 5632 $, which by case of 0.75 € / 1$ rate 4224 € is the value. According to the Radó-method calculation the value of the tree is, if the standard nursery sapling price at $6110 (20 €) and the multiplier 295 then the value is 1802450HUF, or 5852€.
The basic value for the ash tree by the Párkányi method the standard nursery sapling price (6110, from 20€) and the annual tree value multiplier (315) 1924650HUF by exchange rate 308HUF/1€, the value is 6249 €.
At the investigation it was found at 90% health estate of crown (0.9) and the type of area has a (0.75) multiplier in. Therefore, the individual value of Fraxinus excelsior is 1924650HUFx0,9x0,75 = 1299139HUF and 6249 €x0,9x0,75 = 4218€..
So far the tree value was in focus of our tests. If we know the value of this tree can be calculated based on the value of a square meter leaf area. Assuming that the tested high ash tree is 100 cubic meters, the leaf area is 400 quadrate meter. Based on this 4218€/400 quadrate meter = 10,55 € /quadrate meter is the value of the unit leaf area for green areas.
Urban green spaces can determine the value of other crops as well. Calculated on the basis of one (Rado or Párkányi) method, we can establish the value one square meter leaf area. We can calculate on the basis of leaf area of shrubs, hedges, flower beds on the lawn of the value of money.
One application of the value is the valuation of the turf. One square meter turf has 0.25 square meter leaf area. The value of one square meters of lawn is 1 x 0,25 x 10,55€ = 2,64€ in this location. This value is real for the lawn in good condition.
The value of green space in built (non-living) elements can be calculated based on the construction costs. The individual elements can wear the amortized cost. The total value of green space is the values of living (plant) and the built elements.
Further investigations, we wish to consider a significant green space that was created during the rehabilitation of the city of Kecskemét. The Rákóczi street - "Vasútkert" revitalization project with a total budget of EUR 7 million, achieved Euro 5 million in funding.
We will attempt to use public opinion to assess the green area. We will determine the total value of the green area of the previously described method. There are currently compiling and testing the survey began.

4. Discussion

The determination of the value of trees is the most advanced areas of green space evaluation. The development of methods started over a hundred years. The direct economic utility rate initially, and then more and more sophisticated methods have been developed. Gradually released and the particularities of the individual tree's age and health status of the species taken into account, are quantified. The matching of ornamental trees in the local environment has become a factor in determining value. The microclimatic effect of the trees has moved to the forefront in the second half of the twentieth century. The current tree assessment methods in Hungary are based on the approach that Dezső Radó worked out.
One way to determine the combined value of green space is summation of individual elements. The international research is directed towards examining the combined value of green spaces.

5. Conclusion

The value calculations presented in high value ash tree as an example showed that, depending on the methods yield different values. But it can be said that the extent of the differences are not that big. We cannot say that any methods would be obsolete or unfit. The green areas, especially in urban green areas have a complex effect on the human environment. Therefore, complex assessment methods should be applied. In further research we also need to take this into account.

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THE REPRESENTATION OF BUSINESS ETHICS TOPICS IN THE STUDY PROGRAMMES AT HIGHER EDUCATION INSTITUTIONS IN THE REPUBLIC OF CROATIA

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Abstract

The application of business ethics in everyday business involves a decision by the management that it is implemented in all organizational units continuously. Once the company commits itself to the application of the Ethics Code, it is mandatory for all employees in the company.

Conflict of management objectives is reflected in the choice of alternatives: to make a profit at any cost (which measures the management performance) or strive for long-term stable relationships with customers, suppliers, employees and other stakeholders in the internal and external environment of enterprises (this is the kind of stability more difficult to measure).

Higher education institutions have not only educational but also a pedagogic role in issues of business ethics. This paper analyzes the representation issue of business ethics as a subject in the curriculum studies programs in the fields of economics at universities in the Republic of Croatia.

Keywords:

business ethics, curriculum, higher education institutions in Croatia

1. Introduction

Stable and sustainable development of the company includes the realization of multidimensional targets. In addition to making profits at the end of the financial year, long-term business stability with constant income must be maintained.

This implies mutually beneficial relationships with suppliers, customers, employees, the government and its agencies, local communities and many other stakeholders.

The task of each company is to make the world a better place. On the other hand, governments are often facing the issue of dealing with the accumulated problems pertinent to social exclusion of certain groups in society, regional underdevelopment, environmental and many other problems. It is therefore understandable that concepts such as environmental protection, sustainable development, local community, education, employee development and alike are studied today.

Education of subsequent generations of students of economics is a particularly responsible task of higher education institutions towards society. The education sector is responsible for the achieved competencies of their students. These competencies must serve society as a whole. Therefore, it is the academic community responsibility not only to educate but to act pedagogically.

Building a stable future for all countries is promoted by the United Nations Development Programme, in whose report Republic of Croatia is ranked 47th in the world, out of 187 countries on the human development index [1].

The new EU strategy 2011-14 for Corporate Social Responsibility gives a new definition of CSR as "the responsibility of enterprises for their impacts on society" [2].

This definition imposes the concept of corporate social responsibility that requires pre-built system of values and the recognition of multidimensional company goals. For socially responsible companies ethically conscious individuals and generations are required.

Business ethics as a subject in the curriculum of study programs in Croatia can certainly contribute to building the value system of students and complete picture of the way in which managers and employees of the company must behave, what goals to choose and the possible outcome of individual enterprise targets relating to customers, suppliers, state, local communities and other stakeholders.

2. Methods

The aim of this paper is to determine using the method of analysis whether there is a separate subject curricula of business ethics in professional undergraduate and graduate professional studies in the fields of social sciences, fields of economics at public and private universities in the Republic of Croatia.

Besides finding whether this curriculum exists in the programs of study at universities, this analysis

method will determine the status and level of education it is taught.
The sources of analysis are the existing curricula of all professional undergraduate and graduate studies in the fields of economics of public and private higher education institutions listed by the Agency for Science and Higher Education and pertaining to the required field of economics.
The list of existing study programs is publicly available on the Agency for Science and Higher Education of the Republic of Croatian website. Study programs that are the subject of analysis are also publicly available on the higher education institutions official websites. [3]
The survey was conducted during July and August 2014, according to the following information:

- title of the program and level of the program. The subject of analysis are all study programs of undergraduate professional studies and all graduate studies in the field of economics.
- performer. Subject of analysis are all public and private higher education institutions that perform previously mentioned programs.
- the existence of the Business Ethics subject. All accredited professional degree programs are reviewed by the structure of subjects, followed by filtering those which cover the topics of business ethics and deal with these topics within the framework of the curriculum.

Table 1 gives an overview of academic programs in the field of economics.

Table 1 List of study programs and a list of program performers [3]

Study program	**Performer**
International Business	RIT Croatia
Business Management	College of Karlovac
Management	College of Slavonski Brod
Economic and regulatory framework of entrepreneurship	College "Marko Marulić" in Knin
The management of tourism and sport	Polytechnic of Međimurje in Čakovec
The management of sport and sporting activities	Business School "Libertas"
Management of small and medium enteprises	Higher School of Economics, Entrepreneurship and Management "Nikola Subic Zrinski"
Accounting and Finance	University of Split
Commercial business	University of Split
Business Communications Management	VERN
Accounting and Finance	VERN
Entrepreneurial Economics	VERN
Marketing and Communications	Business School "Zagreb"
Management of Market Communications	College of "Agora"
Service Management	RIT Croatia
Tourism; Studies: Tourism Management, Hotel Management	VERN
Business Informatics	VERN
Small Enterprise Management	University of Split
Tourism Operations	University of Split
Management in Tourism	Business School Višnjan
Business Economics	Business School "Libertas"
Economics and Management	Zagreb School of Economics and Management
Business and Management	College of Business and Management "Baltazar Adam Krčelić"
Management; Studies: Tourism Management, Information Management	College of Šibenik
Finance, Accounting and Auditing	University „Juraj Dobrila“ in Pula
Catering	College of Karlovac
Entrepreneurship	College of Rijeka
Commercial business	University in Split
Accounting and Finance	University in Split
Management; Studies: Information Management, Management of Rural Tourism	Higher School of Tourism and Information Technology in Virovitica
Entrepreneurship; Studies: Rural Entrepreneurship, Business Services	Higher School of Tourism and Information Technology in Virovitica
The management of tourism and sport	Polytechnic of Međimurje in Čakovec

Accounting	College of Požega
Commerce	College of Požega
Commerce	College "Lavoslav Ružička" in Vukovar
Tax studies	University of Zagreb
Operational management	College "Hrvatsko Zagorje"in Krapina
Management	College of Slavonski Brod
Trade business with entrepreneurship	College "Marko Marulić"in Knin
Economics of Entrepreneurship	College "Nikola Tesla" in Gospić
Entrepreneurship	College of Rijeka
IT management	VERN
Management of internal and international trade	Business School "Libertas"
Management Banking, Insurance and Finance	Business School "Libertas"
MBA	Zagreb School of Economics and Management
Management	College of Šibenik
Service Management	RIT Croatia
Entrepreneurial Management	VERN
Management in Agriculture	College of Križevci
Financial Management	College of Business and Management "Baltazar Adam Krčelić"
Management in Tourism	Business School Višnjan
Commercial business	College of Požega
Management; areas: Project Management, Tax Management, Accounting	University of Split
MBA program	International Graduate Business School Zagreb
Creative management of market communications	College of "Agora"
Management of Sustainable Tourism Development	VERN
Accounting and Finance; Study: Accounting - Finance	RRiF College for Financial Management
Business and media management	University North
Entrepreneurial Economics	Higher School of Economics, Entrepreneurship and Management "Nikola Subic Zrinski"
Sports Management	College of Management and Design "Aspira"
Finance and Law	Higher education institution "Effectus" - College of Finance and Law
Management of Finance	Higher education institution "Effectus" - College of Finance and Law
Financial Management	University of Dubrovnik
Business Economics; Studies: Commercial Business, Tourism Operations, Accounting and Finance	University of Zagreb
Business Management	Business School "PAR "
Corporate Finance	RRiF College for Financial Management

These study programs are analyzed by the structure of the study curriculum and the required contents of business ethics in an independent subject of business ethics.

3. Results

The Table 1 analyzes 66 study programs. These are programs of undergraduate and graduate professional studies in Croatia.

University programs have not been analyzed, but the focus was placed on professional studies which should be more convenient and enable graduates an easy access to the economy.

Among the 65 analized study programs just for one of them the curriculum data were not available, so the analysis includes the remaining of 64 programs.

From a total of 64 performed programs 57.81% are the first level educational programms of professional studies lasting 3 or more years, and 42.19% are specialist professional graduate study.

The first graph is an overview of the professional courses structure in the fields of economics in the Republic of Croatia.

Table 2. The structure of professional studies in the fields of economics in Croatia

Professional programmes	*in percentage (%)*
Professional programme of 3 or more years duration	57,81
Specialist graduate professional programe	42,19

Study programs were analyzed per semester and individual study years. The analysis presented whether business ethics is performed as mandatory or optional course.

A review of the curriculum of undergraduate professional studies (N = 37) shows that business ethics course is performed within the 21 study programs (56.75%), of which as a mandatory course in 14 programs (37.83%, compared to the total number of undergraduate professional studies) as well as optional course in 7 programs (18.92% compared to the total number of undergraduate professional studies).

A review of the curriculum of graduate professional studies (N = 27) shows that business ethics course is performed within the 14 studies (51.85%), of which as a mandatory course in 10 programs (37.04%, compared to the total number of graduate professional studies) as well as an optional course in the 4 programs (14.81%, compared to the total number of graduate professional studies).

A total of 6 undergraduate professional studies programs and 7 graduate professional studies programs which include the term "management" in their study program names, does not have built-in contents of business ethics and socially responsible business.

4. Conclusion

The Republic of Croatia as a new member of the European Union should strongly support the values that contribute to the sustainability of society as a whole.

In the new EU strategy 2011-14 for Corporate Social Responsibility there is also a new definition of CSR as "the responsibility of enterprises for their impacts on society".

The educational sector in particular has the responsibility due to the student's competency of new generations who are carriers of the future and to incorporate new values of social responsibility and sustainable development.

In this sense the importance of business ethics in study programs in the field of economics is very significant, because these study programs in Croatia are in the largest number.That's why the future managers are expected to behave responsibly and ethical.

The quantitative analysis of undergraduate and graduate professional studies performed by higher education institutions in Croatia shows that business ethics issues are poorly represented.

It is especially concerning fact that even those study programs which include terms "management" or "enterpreneurship"in their names have not contents of business ethics and corporate social responsibility.

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COMPARATIVE ANALYSIS OF SELECTED GENERATING AND RECEIVING MARKETS OF ORGANIZED TRIPS IN EUROPE

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Abstract
This paper will analyze those tourist generating markets from which Croatia achieves the highest number of visitors and tourist receiving markets which are considered to be its biggest competitors. All the relevant factors affecting the choice of receiving destinations of leading generating tourist markets will be also analyzed. In order to determine the real position of Croatia as an election on the main generating markets of organized trips in Europe and in order of cognition of the factors that affect its lower position in certain markets, it is necessary to perform the analysis of other leading tourist generating markets from where Croatia achieves significantly lower number of tourist arrivals in recent years. For this purpose, it will be also analyzed the generating market of Great Britain and the Scandinavian countries market.

Keywords:
generating markets, receiving markets, organized trips in Europe

1. Introduction

For many years the order of tourism generating countries from which the largest number of visitors come to Croatia, remains unchanged. So it was in 2011 which represents the base year for the analysis of key data on these generating markets. The analysis includes 9 countries and their generating markets observed from the angle of Croatia as a receiving market.

2. Analysis of the generating market of Germany

Germany traditionally belongs to the world's top tourist generating markets and the German tourists in 2011 achieved an extremely large number of travel. According to UNWTO data, Germany also leads with tourist consumption at the global level. In 2011, the overall consumption of 84 billion dollars (61 billion euros) has been achieved [1]. Also, the largest number of package arrangements is selling in Germany. In accordance with these data, this country is rightly considered the world's major tourism generating market. Germany is also the leading generating market for Croatia from the early beginnings of tourism in Croatia. From the total number of tourist arrivals in Croatia in the period from 1970 until the war in Croatia, between 20 and 25% were tourists from tourism market in Germany [2]. Germany is with the large and stable advantage remained the leading destination for domestic population, including foreign destinations as Spain in the first place, with a share of 12.3% of total trips, followed by Italy and Turkey. Croatia occupies sixth place with 2.7% share [3].

Table 1. Favorite destination of German tourists in 2011 in percent [3]

Destination	Share in total number of German tourists who traveled to foreign countries
Spain	12,3
Italy	8,2
Turkey	7,4
Austria	5,2
France	3,0
Croatia	2,7
Greece	2,6
Poland	2,3
Netherlands	2,1
Denmark	1,8

3. Analysis of the generating market of Slovenia

Although it is small with the size and population, Slovenian generating market in Croatia has a great importance. It is Croatia, primarily the coast and islands, most desirable and most visited destination for Slovenian tourists. This claim is proven by the latest researches where Croatia is ranked first in terms of passenger journeys of Slovenia in Europe. Slovenian market is characterized by high stability, very good knowledge of Croatian tourism offer and proximity. In 2011, 60% of the Slovenian population realized at least one trip on vacation. Overall, it is generated 4.8 million trips, of which 44% in the country, and 56% abroad [4]. As mentioned, a favorite destination for Slovenian tourists in 2011 was Croatia where it is realized 46% of all trips of Slovenians. After Croatia, they traveled in their

own country with a share of 24%, and then in Italy, 4%, 2% Spain and Greece 2% [4].

Table 2. Favorite destination of Slovenian tourists in 2011 in percent [4]

Destination	Share of total journeys of Slovenian tourists
Croatia	46
Slovenia	24
Italy	4
Spain	2
Greece	2
France	2
Turkey	2
Other European countries	14
Non-European countries	3

Slovenian travelers traditionally prefer to choose destinations in their surroundings, such as Croatia and Italy, easily accessible by car. Therefore, the tours organized by tour operators and travel agencies are not as numerous as in some other markets. Finally, the fact that Slovenians prefer a destination in Croatia rather than in their own country reflects the fact how Croatia is attractive destination in Slovenia and what is the importance of this generating market for Croatia.

4. Analysis of the generating market of Italy

Italy, with around 58 million inhabitants, is one of the most important generating markets of Europe. 25 to 30 million people are traveling on vacation from Italy per annum, of which 15-19 billion outbound [5]. In 2011, Italians realized 29,295,000 overseas travel which is 17% less than the previous year when was realized 29.923.000 Italian tourist trips abroad. In 2011, 1.150.311 Italian tourists arrived in Croatia which is 13% more than in 2010 [6]. When it comes to choosing a destination in which they can spend their vacation, Italians prefer to choose a destination in their own country. Thus in 2011, even 75.2% of Italians spent their vacation in Italy. When it comes to short trips to three days, the percentage is even higher - 91.3%. Of the total number of passengers who spent their vacation outside of their country, even 80.9% chosen the particular destination in Europe [6]. A popular European destination for Italian tourists is France, followed by Spain, Greece and the United Kingdom. Croatia is in fifth place when it comes to long journeys on vacation. If short trips up to 3 days would count in this ratio, Croatia would not be among the top 10 countries. This proves how much space Croatia still has to improve the position of the generating market of Italy.

Table 3. Favorite destinations of Italy tourists in 2011 in percent [7]

Short trips (less than 3 days)		Long trips (more than 3 days)	
Europe	**100**	**Europe**	**80,9**
France	23,0	France	15,6
Spain	13,6	Spain	14,3
Germany	12,4	Greece	9,4
Austria	9,5	Great Britain	7,9
Great Britain	8,3	Croatia	5,5
Other	-	Other	19,1
		Egypt	**5,5**
		USA	**4,3**

5. Analysis of the generating market of Austria

According to data from the Austrian Statistical Office, Bundesanstalt Statistik Österreich, in 2011 was realized 6.5 million tourist trips of Austrian population which represents an increase of 5.4% compared to 2010. Vacations in their own country in 2011 spent 44.6% of Austrian tourists, while vacation abroad spent 55.4%. Using the holidays in their own country compared to the previous year increased by 8.8% and to 2.9 million tourist trips. Travel abroad increased by 2.8% to 3.6 million tourist trips [6]. Analysis of the Bureau of Statistics Austria shows that in the summer months (July to September 2011) the most popular foreign destinations of Austrian passengers were Italy and Croatia which achieved the highest increase in the number of arrivals in this year, followed by Germany, Spain and Greece.

Table 4. Favorite destinations of Austrian tourists in 2011 in percent [8]

Destination	Share of total journeys of Austrian tourists who traveled to foreign countries
Italy	23,8
Croatia	17,5
Germany	13,2
Spain	6,7
Greece	5,2
Other	33,6

Croatia is very well positioned in the Austrian market, where, year after year, increases market share. Italy is slowly losing its tourist importance for Austrian tourists, although it is still in first place, and the reason of the decline is in old-fashioned hotel capacities and partly inadequacy tourist offer. The largest tourist breakthrough in the Austrian market in 2011 made Turkey with the "all inclusive" offer, but also with a variety of tourist services. Insecurity, the possibility of riots and strikes are the biggest disadvantages of Greece, Egypt and Tunisia [9].

6. Analysis of the generating market of Czech Republic

In 2011, the residents of the Czech Republic achieved more than 20 million trips on vacation. Of the total number of tourist travel, 4,327,000 (21%) has been achieved abroad and 16,176,000 (79%) was within the country [9]. In 2011, due to the economic crisis, Czech tourists lost interest in distant, exotic destinations. Destinations such as Egypt, but even Spain, Greece and Bulgaria thus lost their popularity, while in the positive direction shifted France, Germany, Hungary and Austria. But arguably on table with favorite destinations for Czech tourists in the first place for many years stands Croatia. A large number of Czechs never left their own country during the holiday so the number of holidays spent in the Czech Republic in 2011 grew by 20%, while the number of holidays spent abroad decreased by 10% [9].

Table 5. Favorite destinations of Czech tourists in 2011 in percent [9]

Destination	Share of total journeys of Czech tourists who traveled to foreign countries
Croatia	21,6
Italy	15,3
Slovakia	14,6
Greece	8,7
Austria	7,1
Spain	6,3
France	5,8
Egypt	5,7
Turkey	4,7
Hungary	2,8
Great Britain	2,2
Other	5,2

According to the Czech Bureau of Statistics, the share of organized trips in the total number of trips of Czech tourists in 2011 was 51%. However, there were significant differences in the proportion of organized and individual trips depending on the destination to which they traveled. Thus for distant destinations such as Egypt, almost all trips was achieved through tour operators, while to Slovakia, Austria and Croatia Czech tourists traveled individually in a large percentage [9].

7. Analysis of the generating market of Great Britain

The GB market has been known as one of the leading generating markets of Europe in the past. Because of the crisis and the economic situation in the country and region, that fact is a bit changed, but the population of Great Britain gladly travels, especially abroad and to attractive European destinations. The GB market in 1990 was the fourth-largest generating market for Croatia, with a 7 percent share in realized foreign tourist visits (overnight stays) and was considered as a typical market of organized trips to Croatia [10]. Unfortunately, the situation is different today and Croatia does not frequently among the favorite destinations of British tourists any more. There are many reasons for that. "Croatia has felt a decline in turnover from the British market, primarily due to the high cost of hotel services, the imposition of the VAT rate of 10 percent on an organized foreign trade and the abolition of subsidies for the organized air transport. It is well known that the Great Britain is typical generating market of package tours depending on air traffic. British tour operators have warned about continuous growth of cost of accommodation, which is why Croatia has almost become uncompetitive in the Mediterranean because, according to them, the price did not match the quality [11]. In 2011, the British residents generated a total of 182.6 million trips, of which 56 million abroad and 126.6 million in the country [9]. Favorite foreign destinations of British tourists for many years haven't changed, thus in 2011 Spain confirmed its position at the top of the list of favorite destinations in the tourist generating markets of the Great Britain followed by France, the United States and Ireland. Tourist trips to Europe, which is certainly the most popular destination for British tourists, in 2011 grew by 2.5%, while North America and the rest of the world recorded significantly lower number of British tourists - 12.5% and 9.5 %. The share of travel of all British residents realized in Croatia is only 0.4% [9].

Table 6. Favorite destinations of British tourists in 2010 and 2011 in millions [9]

	Number of journeys in millions	
Destination	2010	2011
Spain	10,3	10,6
France	9,0	8,9
USA	3,2	3,1
Ireland	2,9	3,0
Italy	2,2	2,3
Greece	1,7	1,9
Germany	2,0	2,2
Netherlands	1,7	1,8
Portugal	1,8	1,9
Turkey	1,8	1,6

8. Analysis of the generating market of Scandinavian countries

Scandinavia is a term which includes three Nordic countries - Norway, Sweden and Denmark. The Scandinavian countries are, mainly due to the fact that these are countries with harsh, cold climate and generally unfavorable weather conditions (long and cold winters, short and rainy summers), particularly interested in Mediterranean countries,

so the journeys are motivated by existential need for sun and warmth. These are countries with very high living standard of the population, relatively high income and long vacations (5-6 weeks). For these reasons the Scandinavian region, despite a small population of about 25 million, makes it the third European generating market [9].

Sweden. Around 11 million trips abroad have been realized at the generating market of Sweden in 2011, of which 320,000 trips were realized in the Nordic and Baltic countries. The main destinations were Denmark, Norway, Spain, Finland and Germany. In 2011 was recorded 156,000 arrivals (652,363 overnight stays) of Swedish tourists in Croatia, which is an increase of about 10,000 tourists compared to 2010 [9].

Table 7. Favorite destinations of Sweden tourists in 2011 [12]

Destination	Number of journeys
Spain	1.196.000
Germany	906.000
Great Britain	575.000
Italy	489.000
Turkey	452.000
Thailand	443.000
France	433.000
Greece	428.000
USA	376.000
Croatia	156.000

Denmark. At the generating market of Denmark 7,600,000 passengers traveled abroad on holiday in 2011. According to research, about 69% of Danes independently booked and organized trip for themselves, and the remaining 31% traveled within an organized trips by the agency or tour operator. Shorter trips (up to 3 nights) are realized mainly in Denmark, in 2011, 78% of which are the most commonly triggered by a visit to relatives or friends. When it comes to traveling abroad, for Danes favorite destinations are very similar to those which are chosen by Swedish tourists. And these are primarily Spain, Sweden, Germany, Norway, etc. [9].

Norway. The third Scandinavian country, Norway, although one of the most sparsely populated countries of Europe (5 million inhabitants), occupies 19th place on the rankings of the main generating markets of UNWTO. In 2011, the total number of trips with at least one overnight stays was 22.9 million. Most visited destinations by Norwegian tourists are Sweden, Denmark, Spain and France. The most common way of provision of services is directly from the service provider, and relatively well represented are provisions of package tours through the Internet [9].

Table 8. Favorite destinations of Denmark tourists in 2011 in percent [9]

Destination	Share of total journeys of Denmark tourists
Spain	13
Germany	8
Italy	7
France	6
Austria	6
Turkey	6
Greece	5

9. Conclusion

In 2011, Croatia has traditionally been the most visited by numerous tourists from Germany whose arrivals amounted 1.7 million with 12.5 million overnight stays. On the second place is Slovenia with 1.1 million arrivals and 6.4 million overnight stays. Italy follows with 1.2 million visits and 5.0 million nights and Austria with 892,000 visits and 4.8 million overnight stays. In fifth place, by the number of overnight stays there is a Czech from which have been recorded 638,000 visits and 4.4 million overnight stays. Croatia in 2011 generated a total of 11.5 million tourist arrivals (8% more than in 2010) and 60.4 million overnight stays (7% more than in 2010). Of the total number of tourist arrivals, 87% were foreign tourists, and thus in 2011 was recorded 9.9 million foreign arrivals (an increase of 9% compared to 2010), who have made 54.8 million overnight stays (an increase of 7.4%). Taking into account the above data, in accordance with the data in Table 3, it can be concluded that almost ¼ of foreign tourist arrivals and overnight stays are made by tourists from Germany and their number is growing at a relatively high growth rate of 8%. The analyzed data indicate that the generating market of Germany is certainly the most important tourist generating market for Croatia. Although a small country, Slovenia is also a very important tourist generating market for Croatia, settling into second place by the number of tourist arrivals and overnight stays. This market is also marked by upward trend of 7% in the number of tourist arrivals compared to 2010. Tourists from Italian generating market generate a slightly higher number of visits than Slovenian tourists, but a much smaller number of overnight stays. The reason for that are certain specifics of the Italian generating tourism market compared to Croatia. First of all, the proximity of these two countries provides a fast influx of tourists and a short stay in the area. The proximity of the market is often inversely proportional to the number of days spent in the area by tourists. Of course, there are exceptions, such as the generating market of Slovenia. It is important to note that the Italian generating market in 2011 is marked by increase in the number of tourist arrivals in Croatia at the

highest rate (of the analyzed countries) compared to 2010 - even by 13%. Tourist generating markets of Austria and the Czech Republic occupy fourth and fifth place in overall number of arrivals and overnight stays in Croatia and they are characterized by growth in comparison to 2010 as well.

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WOMAN ENTERPRENEURSHIP IN CROATIA

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Abstract
Entrepreneurship and entrepreneur are related terms, and it is impossible to talk about one without other term. An entrepreneur is a person who bears the risk of a business venture, and if it is greater the greater the uncertainty about the future business opportunities. During the last ten years, with the development of small enterprises in the business dictionary introduces the concept of "Women Entrepreneurs", which is very typical for transition countries, i.e. the countries of Central and Eastern Europe. The transition from non-market to a market economy has caused an economic crisis, and therefore unemployment. In most cases, women are the ones that among the first to lose their jobs, and for many of them self-employment or starting their own business lifeline to exit from unemployment. Woman entrepreneurs are thinking about work more comprehensive and realistic look at things from male entrepreneurs. They are more likely to respect other people's opinions and advice collaborators better understand the people, not just customers, but also co-workers and employees, because they are socially sensitive and realistically assessed and evaluated people's behavior. It is important to emphasize that women entrepreneurs as well as male entrepreneurs are highly educated, prone to taking risks and most importantly have developed an entrepreneurial spirit. Woman entrepreneurs prefer transformational leadership, allowing subordinates to align their interests and connect with the interests of the group or company. Today are more visible initiatives to improve women's entrepreneurship within all social and political institutions. These initiatives are primarily aimed at reducing root barriers for women, improving the education system, providing incentives available to women. Unfortunately, discrimination against women in the labor market is still present in mentality is still prevailing stereotypes about gender roles, traditional and outdated belief that women belong with the family and that she has no business in business. On the women's ambition is viewed as something unnatural and the paranormal, where there is power and a large amount of money to women generally has no place. Women must choose career or family while men never ask, but despite the slow economic changes in our country is more and more women in entrepreneurship, disregarding the environment and outdated thinking people, but pushed forward and raise the average woman in entrepreneurship versus male counterparts' entrepreneurs.

Keywords:
Women entrepreneurs, Management, Discrimination, Croatia, Entrepreneurship

1. Introduction

Entrepreneurship is developed between the 12th and 15th century in trade, shipping and currency exchange. At that time, businesses were represented by pirates, merchants, craftsmen, feudal lords, government officials and speculators. In the 12th century in Italy are started to emerge first trading firms, but from the 14th century in the permanent associations which had a form similar to today's public company. Entrepreneurship, as is known today, began to develop in the 17th century, and by that time it talks about the early commercial type businesses that traded fur and slaves. Market competition, technology development and competition for economic leadership are enabling an increase in profits and lead to the concentration of production and capital, and the creation of multinational companies, trusts and other organizational forms. Entrepreneurship is related to the crucial time of crisis conditions, uncertainties and changes in the environment. Economic theory developed entrepreneurship as a base of the economic system and development. "Entrepreneurship can be divided into two types, one concerns small and medium enterprises (individual businesses), and other large enterprises (corporate entrepreneurship)" [1]. Individual entrepreneurship refers to the small (and medium) enterprises; while at the same time entrepreneur is owner of the company and the holder of the risk in the business. Corporate entrepreneurship is related to the functioning of large enterprises. Within these large corporations functions of management, ownership and risk-taking are divided. Holders of the entrepreneurial activities are corporate managers with entrepreneurial skills.

2. Concept of enterprise

In the 1458th in Dubrovnik, Benko Kotruljic in his book "Trade and perfect seller" was among the first in Europe that mentioned concept of entrepreneur. The concept of entrepreneurs in economic science

is introduced by Richard Cantillon 1725th year in his paper "The debate about the nature of trade" in book chapter "Entrepreneur". Cantillon describes an entrepreneur as a person who buys at known prices and sold at an unknown" [2]. Thus, the entrepreneur is a person who bears the risk of a business venture, and he's stronger if the uncertainties regarding future business opportunities are bigger. To achieve entrepreneurial venture and made a profit, entrepreneur must possess certain qualities or characteristics, which are: innovation, reasonable risk-taking, self-confidence, hard work, setting goals, responsibility, quick decision making, like money, oriented towards success, increasing the dreamers of other people, restless spirit are often impatient with people at meetings, etc.

3. Women entrepreneurship

During the last ten years of development of small enterprises it is introduced the concept of women entrepreneurs. This is especially characteristic for the transition countries, and the countries of Central and Eastern Europe. The transition from non-market to a market economy caused by the economic crisis and unemployment that follows, and women all over the world that they first lose their jobs. For most women self-employment by starting their own business - small businesses is one way out of the unemployed. One of the recent reports involving nine countries suggest that women lead new jobs. Women have the creativity, the expertise and skills necessary to start a new business, but often, unlike male entrepreneurs do not have equal access to credit, training and information, without any successful conduct of business. Like their male colleagues women entrepreneurs are highly educated, prone to taking risks and have developed an entrepreneurial spirit.
"Woman entrepreneurs have more comprehensive and realistic discern from male entrepreneurs, are more likely to respect other people's opinions and advice to colleagues. Better understanding for other people, not just customers or users, but also users and employees because they were ready to listen" [3]. Woman entrepreneurs apply modern solutions like decentralized, flexible organization, teamwork, group decision-making and participation of employees in decision making. Women resolve conflicts easier because they are socially sensitive and more appropriate to assess or evaluate the behavior of people. Prefer transformations, allowing subordinates to align their interests and connect with the stakeholders. As a result, despite the slow economic changes in Croatia there are more women into entrepreneurship each day. With the opening of centers for training of women manager, women are increasingly mastering new professional and practical knowledge in the areas of finance, marketing, management, strategy and development, and equally compete with men in finance, insurance and construction. Different legal regulations results an increased number of common business, both in industrialized and developing countries. Just like the law, and traditional family roles decide whether and how to include women in entrepreneurship. Despite more women are involved in the business, primary they are parent, care givers and homemakers. Today are more visible initiatives for improvement of women's entrepreneurship within all social and political institutions. These initiatives primarily reduce barriers for women, improving the education system, providing incentives available to women. However, it still need a lot of time, legal and other changes to women's entrepreneurship in Croatia to a level that is necessary for better enterprise.

4. Networking of women entrepreneurs

"In Croatia, women make up 52% of the Croatian population, their share in employment is 45%, and 52% public and 39% in the private sector. Women in business are represented from 30% to 27% of managerial positions, while only 19% of the supervisory boards of companies. Among the unemployed, their share is almost 59% and at temporarily employed even 86%" [4].
Women in business or so-called women's entrepreneurship is becoming more common topic of numerous conferences, seminars, conferences, programs of governments and politicians around the world. Data on the number of women entrepreneurs vary from country to country, from region to region. While in most countries the number of women entrepreneurs largely lags behind the number of men involved in entrepreneurial activity, there are countries where women's entrepreneurship is the most dynamic segment of the small business sector. It is interesting that in the United States (U.S.) nearly half of all U.S. companies majority-owned by women, while in Canada between 1981st and in 2001, the number of women entrepreneurs has increased by 208 percent, compared with an increase in the number of male entrepreneurs than 38 percent. As Europe is concerned, the situation is somewhat different. The potential of female entrepreneurship is still insufficiently explored source of economic growth and employment, and as things stand now, women make up more than half of the population and only a third are represented in European enterprises. "According to the Global Entrepreneurship Monitor - GEM, which measures entrepreneurial activity, Croatia is at 28th place with regard to women's representation in enterprises of 32 countries that were included in the project (all EU Member States plus some countries in the region)" [5].Men in Croatia as much as two and a half times more

active than women. Often the question arises whether it is necessary to talk about men's and women's entrepreneurship and enterprise development. The answer is always the same: that of the woman entrepreneurship should be developed because it is more sensitive and needs more support to develop. Female entrepreneurship is indeed burdened by various obstacles, as those who torture their male counterparts (insolvency, difficult access to finance, a complex regulatory framework, the shadow economy, etc.), as those specific, generally associated with the characteristics of female entrepreneurship (the lack of support in the organization of society family life, the traditional understanding of the role of women, difficult access to knowledge and skills, etc.). It is important to know that women are emotionally more durable and resistant to the frustration of what makes a modern working environment, possess greater self-control, not hasty and demonstrate greater stability in attitudes. Women see the problem deeper and more logical analytics and are consequently their decisions slower but more rational and better. Women entrepreneurs have less financial ventures, less risk, but the jobs that women entrepreneurs create lasting and are stable. It is characteristic in companies where women owners have few layoffs and that employee are actively involved in the resolution of operational problems. Entrepreneurs especially emphasize the need for greater networking of women at all levels and exchange of information and knowledge. They highlight how entrepreneurial ventures women deserve support national, regional and local authorities, international organizations and projects, and help them to measure their effects.

5. Financing program of women's entrepreneurship

The goal of the program is to encourage the establishment and development of small and medium business entities majority owned by women, according to the Action Plan for the implementation of the Strategy for the Development of Women's Entrepreneurship in the Republic of Croatia for the period from 2010th to 2013th. The amount of loans intended for investment in permanent current assets can be typically up to 30% of the loan and may be granted only with the approval of “de minimis” aid. The amount of investments in intangible assets depends on the professional judgment client and / or project as well as the available sources of funds CBRD. In financing the development of products or services the user is required to submit a detailed business plan with a description of the product or service, purpose of product or service, the target group of users of products or services, the time duration of the development, the planned cost of future products and the associated planned revenues in future periods, planned costs, etc.

“Under loan program is not credited to: parts of investments that serve the personal purposes; purchase, construction and furnishing of apartments, regardless of whether they are investing natural or legal persons; establishments that provide services exclusively pouring drinks; gas stations; casinos, bookmakers and similar activities; sales and service car showrooms; acquisition of immovable and movable property of other persons; construction of residential and commercial space for sale; purchase and construction of housing for their conversion into office space; production and distribution of tobacco products, etc. “[6]

Borrowers may be commercial banks that have Croatian bank for Reconstruction and Development (CBRD) agreed on cooperation in the implementation of this program or directly by companies, dealers, individuals owning an independent business, co-operatives and institutions. End users may be legal and natural persons: that have a registered business in the Republic Croatia, where one or more women own at least 51% of the capital or women registered owners whose administration headed by a woman.

6. C*roatian association of business women*

“Circle- as a symbol of perfect unity and cooperation, was elected for the name and trademark of the Croatian association of business women to present its tasks: active connection and joint efforts to improve the status of women in business and in the family environment”[7]. The circle is not a political organization and not established to represent women only. The desire is to fulfill the objectives together with male colleagues. The task is to increase the level of cooperation within companies, according to the ethical code of conduct, the same as in the social and economic. Support the promotion of capable, hardworking, determined and ethical business people, especially business women, whose great potential has not been recognized or not sufficiently appreciated in the current environment. The goal is to help all business women and their environment in order to do everything they are able to do to improve the Croatian economy and the promotion of appropriate corporate culture and cooperation.

Conference "Women in Business" organized as part of the *European Bank for Reconstruction and Development* (*EBRD*) and Business Advisory Services (BAS) Programme for the promotion of gender equality as an important part of the transition process. “Under this program the EBRD in Croatia financially supported 49 enterprises, about 130 women have passed the training of basic business skills to advanced marketing tools,

and 12 of them participated in the mentoring program "Cherie Blair Foundation"[10]. The most successful among them today were awarded. The prize for the best project received Mirela Mikšić, owner of the floral design studio in Zagreb "Lela design", which is part of this program, has developed a web shop and today 30 percent of sales are generated outside of Zagreb.

7. (Non) equality of women in the labour market

Discrimination against women in the labor market is still present in our society, the latest data available for Croatia said that the proportion of women in entrepreneurship, 30 percent, 27 percent were in management positions, and only 19 percent of them are located in the supervisory boards. In our mentality is still prevailing stereotypes about gender roles, traditional and outdated belief that women belong with the family and that she has no business. On the women's ambition is viewed as something unnatural and the paranormal, where there is power and a large amount of money to women generally have no place. Women must choose career or family while men never ask. Women have 25 percent owned companies, and still cling to the 33 percent of trades, regardless of the negative trends in crafts and their closure, which means that women do their own job well and do not let the end. Male involvement should support the work of kindergartens, school meals and homes for the elderly, in what must be included various ministries, not just the Ministry of Business and Trade. Therefore, do not be surprised by the fact that in Croatia last year there was one female entrepreneurial venture at 2.24 male, while the European average is 1 in 1.9. Croatia lacks a culture of comparison with the better, there is no adequate controls to see how many women actually employed and how much money was spent for the (investment projects, workshops, interest subsidies), as well as new opportunities through the so-called "second chance" for women who have failed in their jobs. The 2010th total employment in Croatia amounted to 54.1% (59.5% in men and 48.8% women), with the difference between men and women was 10.7 percentage points. Comparison of the economic activity of women in Croatia to the EU average shows that the rate of economic activity of women in Croatia is lower than those in the European Union. In Croatia, women compared to men have a lower rate of economic activity, lower employment rates, higher unemployment rates and lower monthly earnings. This means that women are consistently less favorable labor market indicators in relation to men. It is concluded that in Croatia there are significant gender differences in the rate of activity in relation to age. They are higher in younger and older age and at least the most active working age. Age and education level are important determinants of labor force participation, and it can be said that these two determinants are interrelated. This is particularly pronounced in the group of women of advanced age, in which the participation in the labor market are significantly lower than for men, and their level of education compared to men is significantly lower. Croatia has a relatively high percentage of companies that are established for emergency and a relatively low percentage of companies that have been established for business opportunities. Despite numerous initiatives to promote entrepreneurship, Croatian society still does not function as an entrepreneurial society. Therefore, we need to do much to create a favorable business climate. The number of women entrepreneurs in the past six years has increased three times.

“Achieving the goal of equal treatment of women and men in the workplace -it should strengthen institutional mechanisms for gender equality so that these bodies have the authority to act in cases of discrimination, and provide the necessary resources to implement judicial reform, for example, on the way to educating judges to become more gender-sensitive”[8].

Improving women's participation in the establishment and development of enterprises comes to creating an environment that will act as support for the development of entrepreneurship and the establishment of women's enterprises should particularly emphasize the need to provide relevant and complete information, as well as the adjustment of business services to their specific needs. In the future, activities and measures to create an enabling environment should be focused on the following key areas like: reorientation and services (financial and technical) for small and medium enterprises in order to better meet the needs of women who want to establish and develop the company; improving of financial services for women starting and developing businesses; support networks and associations of business women, as well as mentoring activities by women and for women.

There is a need to improve existing services provided in woman employment, and it is as follows: “increasing the number of women in training and retraining programs; increasing flexibility in the way of providing training and retraining measures to ensure they are available to women who are less well-connected; providing support to companies to improve qualifications and working conditions of employees with shorter hours than full-time and other flexible forms of work; promoting special programs / projects aimed at increasing the participation of women in the labor market, particularly in cooperation with local governments and other stakeholders” [9].

8. Man vs. women in entrepreneurship

The fact is that there are twice as many entrepreneurs from woman entrepreneurs because it proves that women are less daring to go into business. All analyzes female vs. male entrepreneurship show that women entrepreneurs are more powerful, more educated, more successful than men when they engage in entrepreneurship. It is indisputable that the crisis that has engulfed our economy affected the company and crafts which are owned by a woman or women are the majority owners. But in our world, and practice it turned out to be entrepreneurs cope with the crisis, they are rational and logical to manage businesses in these situations. One psychologist pronounced wonderful statement which reads: "If a man and a woman find themselves facing the window, then the window to see a man, a woman will look out the window." [10] Men see the problem in front of you and try to resolve it as soon as possible and at first look reasonable, and women see the problem deeper and more logical analytics and correspondingly their decisions are slower but more rational and better. Results of this, called the "female" looking at problems in business is that entrepreneurs are less prone to risky business, they are more organized and learn the practices. In addition to attending far more specialized seminars than male counterparts. This, responsible behavior has enabled entrepreneurs to companies that are owned by women or by women, faster and easier to adapt to the new situation. A realistic assessment of the situation and anticipate the possible consequences, it is an exceptional quality of entrepreneurs, the company launched a reorganization aimed at reducing operating costs and increasing competitiveness. It is characteristic that in companies where women owners were fewer layoffs and that employee are actively involved in the resolution of operational problems. It has been shown that they are capable to animate all employees, from myself to the last employee to maintain the market position of the company in the new conditions. Entrepreneurs create a positive atmosphere in their environment.

9. Conclusion

Croatia needs to develop all kinds of businesses with an emphasis on women entrepreneurs. Currently the economic picture is very bad, and every day more people remain out of work and employment opportunities in the field are almost impossible. This is exactly what can be reasons to encourage people, especially women who are traditionally associated with job housewife, to take advantage of the possibility of self-employment and starting new initiatives in their environment.

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LIVELIHOOD OF ECONOMIC ASSESMENT IN RURAL AREAS

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Abstract

This paper shows how some significant products of Kiskunság, Hungary, an area struggling with aridification can provide the families with the income that they can live on. The products (apricot and cucumber and asparagus) have been selected with the aim to examine different type of products and production methods. The used assessment method is called Standard Gross Margin. The concept of Standard Gross Margin (SGM) is used to determine the economic size of farms, which is expressed in terms of European Size Units. The economical examinations resulted that in order to get the required income the apricot should be grown as a minimum on 10.3 hectares, the cucumber on 0.72 ha with supporting system and white (etiolated) asparagus on 1.66 ha big area letting the family to make ends meet. Due to late spring frosts it is not recommended to base the whole income of a farm on either asparagus or apricot.

Keywords:

orchard training, work-organization, economic evaluation

1. Introduction

The Hungarian food industry and agriculture is one of the most important areas of the national economy. Most agricultural products get to the consumers after food industry processing. The market possibilities of a nation and the competitiveness of the agriculture products are defined by the standard and the state of development of the food industry [1]. From among the changes of the economy of a nation the series of changes of the agriculture are the most particular. Privatisation reorganised the property structure of the food industry to a great extent. In the following years a group of companies run by families and being competitive in Western Europe as well will probably separate from the many people involved in agriculture and they will represent the majority of the Hungarian agricultural production [2]. Because of its geographical situation Hungary is extremely suitable for producing a lot of products of high quality. The fame of these cultivated areas is important for our export-oriented economy of nation. The image of the cultivated area is diverse and besides the particular products the characteristic features of the area, the atmosphere of the place, the characteristic features of the people living there, the past and the history of the area also play a significant role. In case of the unique Hungarian products processed here the consumers have to be familiar with the quality and have to recognise it [3].

Agriculture has been and probably will be a significant branch in the south part of the Great Plain in the future as well. Besides the mass products and in many cases instead of them when forming the agricultural structure, this region has to pay more attention to the branches that were important in the past [4]. Hungarian experts who are famous in foreign countries as well deal with these branches and they provide excellent products. The rules referring to these products are more liberal in the market places of the European Union and their development is not controlled by strict quota systems.

2. The Standard Gross Margin (SGM)

The concept of Standard Gross Margin (SGM) is used to determine the economic size of farms, which is expressed in terms of European Size Units (ESU). This concept is also used in the Farm Structure Survey organised by Eurostat. Definition: For each region all crop and livestock items are accorded an SGM. The Liaison Agencies calculate the SGMs themselves on the basis of empirical data collected from farms. To avoid bias caused by fluctuations, e.g. in production (due to bad weather) or in input/output prices, three year averages are taken. SGMs are expressed in Commission publications in European Currency (EUR/ECU). SGMs are updated every two years and are calculated on a regional basis for more than 90 separate crop and livestock items. This large number of items not only reflects the diversities of agriculture within the European Union but also indicates the level of detail that is required to ensure that the results of FADN and other surveys are both comprehensive and reliable.

Our calculations were carried out with the help of a method worked out and applied in the European Union. In the European Union the agricultural enterprises have been regularly assessed (since 1966) and comparative data have been given to the decision-making organisations of the Union. Because of the number and the variations of the enterprises more than one form of measuring was

applied such as the territory of the factory, the number of the employees, the number of the animals bred and the price of the products sold. As it was experienced the achievement of the agriculture in a state could not have been defined by these forms of measuring and by the combination of them. Similar to this they were not sufficient to determine the economic size of an enterprise and to compare the different factories from economic aspect [5].
The unified classification system (the economy typology) was accepted in 1978 that pays attention to two aspects, the type of farming (the structure of production) and the size of the economy. In order to define the economic size the Standard Gross Margin (SGM) was worked out [6]. The natural data referring to the structure of the factory cannot say anything about the achievement of the agriculture of a country and they are not good for economic comparing. The size of the factory is defined the best of all by the potential profitable capacity which equals with the total standard gross margin (SGM) of the particular factory -which is the same as the added value [7].

3. The calculation of the SGM

According to the regulations of the European Union, in cultivation of plants the costs of the seeds, the propagation, the artificial fertilizers, the insecticides, the heating, the irrigation, the processing, the classification, the packing, the insurance and other variable costs that are connected with the particular production activity have to be taken into consideration among the direct variable expenses. The indirect variable costs are also defined. The variable expenses in connection with the machines belonging to the factory (such as fuel, lubricants, repairing costs) are listed here. These two groups together mean the variable costs of the economy. It does not include the costs of amortization and the rent of the agricultural land. This method takes into consideration every wages and their complementary costs as constant expenses without paying attention to whether they were paid to the owner of the farm or to a family member or to an employee. The amortization costs of the tangible assets, the rent of the agricultural land and the general costs are referred to as constant expenses. The SGM1 and SGM2 index numbers can be calculated on the basis of the relations mentioned above.
SGM1 = sales – direct variable cost (direct material costs)
SGM2 = sales – direct variable cost – indirect variable cost (the direct material costs and the direct costs of machine work are deducted from the sales). The SGM2 index number is in fact the gross income.

4. The necessity of live labour

The basis of the economy producing unique Hungarian products is to deal with growing plants that assure the costs of living for a long time; can be easily produced in the south of the Great Hungarian Plain, can be easily sold in the market and can be produced by own live labour. The necessity of live labour has to be determined especially in the harvesting and the selling period. It can be calculated on the basis of detailed producing technology. In this essay we determine the area that a family can cultivate on its own – without employing workers seasonally. If we take a family with four members we calculate with three manpower units. In our earlier research the working days and working hours in cultivation of plants were defined. These data are essential to calculate the necessity of live labour especially when we plan the working peak. In the harvest phase we calculate with 7-10 working hours per manpower units a day. The family can perform 200-250 hours every ten days.

5. The economic assessment of the apricot

The basis of the production is the apricot plantation, which has a good effect on the farming. After planting there are four or five years without harvest but the field must be cultivated although there is no income and no other plants can be grown meanwhile to utilize the area. The factor cost of one hectare is 12.800 Euro. The length of the period when there is harvest is 20 years. The accountable depreciation is 6% per year.
The variable cost of the enterprise is encumbered with almost 500 Euro per hectare. This includes the costs of the materials, the artificial and organic fertilizers, the pesticides, the packing and the processing. The indirect variable cost of the farm – according to our survey - is 420 which gives a result of a total 920 Euro variable cost. In the Great Hungarian Plain – taking into consideration the areas not abounding in nutrients – we can calculate with 6.5 ton average yield per hectare. The distribution must be calculated with care with a 0,32 Euro/kg - average price. The income is 2.800 Euro per hectare. The biggest peak of work appears during the harvest. Taking into consideration the number of working hours 2.7 hectare of apricot plantation ripening at the same time can be accomplished without employing workers for this season.
SGM1 = 2.800 Euro income – 500 Euro direct variable cost = 2.300 Euro / year / hectare
SGM2 = 2.800 Euro income – 500 Euro direct variable cost – 170 Euro indirect variable cost = 1880 Euro / hectare/ year.
The SGM2 for a 2.7 hectare is 3.132 Euro.

6. The economic assessment of the cucumber

The support system for growing cucumber assures bigger quantities and better quality comparing to the plough-land cultivation. The cost of it is 3600-4400 euro per hectare that does not include the farmer's labour. This system can be planned for ten years and can be applied when growing tomatoes as well. A particularity of growing cucumbers intensively is that the size of the desired product is in inverse relation to its yield and average price. The yield is lower if we pick cucumbers every day which are 1cm-3cm, 2cm-5cm and 3cm-6cm big and their price is higher. In the model we plan to pick 3cm-6cm and 6cm-9cm big cucumbers every two days.

From among the direct variable expenses the costs of artificial and organic fertilizers, pesticides, plants, irrigation and other variable costs were calculated in our project. The direct variable cost of the cucumbers grown on family farms with the help of training system and irrigation is 600 euro per hectare. In our technology 800 euro per hectare variable cost was calculated taking into consideration the running and the repairing costs of the machines of own property. The total variable cost in a year (1.400 euro) was compared to the probable income. The yield can reach 80 tons per hectare in the south of the Great Hungarian Plain if irrigation is applied. The 0,24 euro/kg average price could assure the farm a 19.200 euro income. We must not forget about the fact that such an intensive planting culture requires 800 euro costs per hectare at the beginning taking only an average data. This cost cannot be taken into consideration among the expenses (according to the terminology of the European Nations). Similarly to this the salary cannot be deducted although the application of live labour is the highest in case of growing plants in the fields.

7. The economic assessment of the asparagus

The basis of the production is the asparagus plantation, which has a good effect on the farming. After planting there are three or four years without harvest but the field must be cultivated although there is no income and no other plants can be grown meanwhile to utilize the area. The cost of plantation and cultivation is 8.0000 euro in the proportion of 85+5+5+5 every year. Besides this 1600 working hours are needed. The factor cost of one hectare is 10.400 -12.000 euro. The length of the period when there is harvest is 6-8 years. The accountable depreciation is 15% a year. During this period the quantity of the yield is not the same: in the first two or three years it is growing, then it is stagnating for two or three years and after that it is decreasing. In this model we calculate with the yield of a stagnating year. The variable cost of the enterprise is encumbered with almost 220 euro per hectare. This includes the costs of the materials, the artificial and organic fertilizers, the pesticides, the packing and the processing. The indirect variable cost of the farm – according to our survey - is 170 which gives a result of a total 400 euro variable cost. In the south of the Great Hungarian Plain – taking into consideration the areas not abounding in nutrients – we can calculate with a five- ton average yield per hectare. The distribution must be calculated with care with a 16 euro/kg - average price. The income is 8.000 euro per hectare. The biggest peak of work appears during the harvest. Taking into consideration the number of working hours 0,97 hectare of asparagus plantation ripening at the same time can be accomplished without employing workers for this season.

SGM1 = 8.000 euro income – 220 euro direct variable cost = 7.780 euro / year / hectare

SGM2 = 8.000 euro income – 220 euro direct variable cost – 170 euro indirect variable cost = 7.610 euro / hectare/ year.

The SGM2 for a 0,97 hectare is 7.390 euro.

8. Conclusions

In order to get the income expected the apricot should be grown on a 10.3 hectare big area. On such a big area other workers have to be employed during the harvest period for 8-9 workers.

The kinds of the apricot make it possible for the family to make ends meet. On the basis of the significant export, the market for the apricot can be said to be steady. The income depends on the Hungarian sale ring. Because of the frost in late spring it is not recommended to base the whole income of the farm on the apricot. Other recommended products can be the ones the harvesting time of which is not the beginning of June or the middle of July.

The cucumber should be grown with the help of support system on a 0,72 hectare big area. On such a big area other workers have to be employed during the harvest period for 540 working hours. The cost of it is 780 euro.

This kind of cucumber growing makes it possible for the family to make ends meet. On the basis of the significant export, the market for the cucumber can be said to be steady. The income depends on the Hungarian sale ring and the processing. The cost of introducing the post system is high but the income of the first year can cover this cost on a successful farm.

The pale asparagus should be grown on a 1,66 hectare big area. On such a big area other workers have to be employed during the harvest period for 469 working hours. The cost of it is 680 euro. The kinds of the asparagus make it possible for the family to make ends meet. On the basis of the significant export, the market for the asparagus can be said to be steady. The income depends on

the Hungarian sale ring. Because of the frost in late spring it is not recommended to base the whole income of the farm on the asparagus. Other recommended products can be the ones the harvesting time of which is not the beginning of April or the middle of June.

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ANALYSIS OF TOURIST MARKETS OF ORGANIZED TRIPS IN CROATIA

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Abstract
The paper defines the factors underlying the Croatian tourist offer and analyzes previous results in Croatian tourism, all in order to identify relevant trends existing in the Croatian tourism since its independence and earlier. Then it analyzes the current share of tour operators, especially the leading specialist tour operator for Croatia who works in Croatia. The purpose of this paper is to ultimately connect all the conclusions of the study in order to identify set goals. So, in order to know what is the actual representation of Croatia in programs leading tour operators that acts on foreign tourist generating markets, what is the position of Croatia in relation to other competing destinations and the role of tour operators specialized in organizing trips to Croatia. At the end of the paper further development of specialist tour operator for Croatia is presented.

Keywords:
Tourism, market, tour operators

1. Introduction

The development of tourism in Croatia is based on several basic factors: natural, cultural and historical heritage, transport and municipal infrastructure, the support of the public sector and sustainable development of tourism.[1] The basic prerequisite for the development of tourism in a given area are attractive natural and anthropogenic resources that have a high degree of attraction for visitors. Among the main advantages of Croatian tourist destinations as receptive important place occupies a beautiful and varied landscape, especially the rugged Adriatic coast with many islands. Due to the mild Mediterranean climate, this coastal area is very suitable for summer swimming and nautical tourism. In addition to the sea Croatia especially in certain destinations has numerous other natural and anthropogenic resources: rivers, lakes, mountains, spas, cities, enabling the development of many types and specific forms of tourism.

2. Critical analysis of the basic physical parameter of tourism in Croatia

Croatian advantages compared to the main competitive countries arising from its natural basis the high level of conservation of coastal areas, beaches and natural vegetation and forest that covers large parts of the territory. Croatia in a relatively small area contains 8 national parks, and is ranked in ecologically best preserved in Europe. There is still a lot of protected natural parks, and Croatia has 4,300 plant and as many animal species. The country also boasts with three different climate zones. Mainly in the tourist sense, known as the Mediterranean destination with an extremely pleasant climate in the coastal area, above-average number of sunny days, dry and hot summers and mild wet winters. Croatia, with regard to its total area, and highlights a number of attractive tourist protected natural areas and the biodiversity is located at the top in Europe.
In the 2011th Croatia recorded 11.5 million tourist arrivals which is 8% more than the previous year. Of the total number of tourist arrivals, domestic tourists made up 13% (an increase of 2% compared to 2010. year). Foreign tourists make up 87% of arrivals, so it recorded 9.9 million foreign tourist arrivals, an increase of 9% compared to the year 2010. In order to make it more detailed analysis of trends in the Croatian tourism will envisage data on actual tourist arrivals and overnight stays during the period of 1975th-2011th years. Therefore, the analysis will be carried out arrivals before, during and after the war.

Table 1.Display of tourist arrivals and overnight stays in Croatia from 1975th to 2011th year in millions [2]

	ARRIVALS			NIGHTS		
	Total	Domestic	Foreign	Total	Domestic	Foreign
1975.	6.454	1.229	5.225	42.411	6.375	36.036
1980.	7.929	1.486	6.443	53.600	7.750	45.850
1987.	10.487	1.731	8.756	68.160	8.397	59.763
1989.	9.670	1.580	8.090	61.849	7,383	54.466
1990.	8.497	1.448	7.049	52.523	6.747	45.776
1995.	2.610	1.125	1.485	13.151	4.388	8.763
2000.	7.137	1.305	5.832	39.183	5.138	34.045
2005.	9.995	1.528	8.467	51.421	5.434	45.987
2010.	10.604	1.493	9.111	56.416	5.424	50.992
2011.	11.456	1.529	9.927	60.354	5.603	54.751

From the very beginning of the development of tourism on the Croatian territory the period of the 1965th year until the beginning of the eighties of the twentieth century is considered to be the most

successful. This period is in the academic literature known as "the Golden Age of Croatian tourism".
After the war, as in the work mentioned above, the national structure of foreign tourists has been significantly altered.[3] Tourists once from the most emissive markets in Croatia such as the UK or the Netherlands turned to other, competing destinations and the number of tourist arrivals decreased significantly compared to the period before the war. Even the tourists with the most important origin market for Croatia, the markets of Germany, did not return in the expected number. The reason for this is the lack of engagement of the tour operators in these markets, and until the end of the century "prewar extremely active foreign tour operators are still not fully accepted Croatia as a new old destination and turn it into a promotional and sales catalogs."

Table 2.The structure of foreign tourist arrivals in Croatia from 1995th to 2011th year by country of origin in millions [4]

	1995.	%	2000.	%	2005.	%	2010.	%	2011.	%
TOTAL	1.485	100	5.832	100	8.467	100	9.111	100	9.927	100
Germany	0.274	18,5	1.048	18,0	1.572	18,6	1.525	16,7	1.661	16,7
Italy	0.221	14,9	1.012	17,4	1.253	14,8	1.018	11,2	1.150	11,5
Slovenia	0.306	20,6	0.849	14,6	0.879	10,4	1.016	11,2	1.010	10,2
Austria	0.247	16,6	0.640	11,0	0.742	8,8	0.810	8,9	0.892	8,9
Czech Republic	0.119	8,0	0.711	12,2	0.616	7,3	0.605	6,6	0.638	6,4
Poland	0.010	0,7	0.285	4,9	0.242	2,9	0.454	4,9	0.495	4,9
France	0.019	1,3	0.057	1,0	0.591	7,0	0.388	4,3	0.395	3,9
Slovakia	0.027	1,8	0.187	3,2	0.185	2,2	0.310	3,4	0.335	3,4
Hungary	0.034	2,3	0.250	4,3	0.453	5,4	0.298	3,3	0.328	3,3
Netherlands	0.026	1,8	0.104	1,8	0.244	2,9	0.285	3,1	0.287	2,9
Great Britain	0.025	1,7	0.085	1,5	0.255	3,0	0.241	2,6	0.256	2,6
Others	0.177	11,9	0.604	10,4	1.435	25,5	2.161	23,7	2.185	22

Ten most important countries in the 2011th in the structure of foreign tourist nights achieved a 77.5% stake, with the largest number of nights traditionally achieved by Germans (22.8%) followed by Slovenians (11.7%), Italians (9.1 %) and Austrians (8.8%) - together for over half of total foreign tourist overnight stays in Croatia (52.4%).
In the 2011th year of the total number of tourist arrivals 37% was organized by the tour operators or travel agencies, and 63% individually. Growth of 8% was recorded in organized tourist traffic compared to 2010 year or 15% compared to 2005 of total organized tourist traffic in Croatia 2011., 88% were foreign and 12% domestic tourists.

Table 3.Tourist arrivals to Croatia, according to the organization of a trip from 1995th to 2011th year, in millions [5]

	Individual			Organized			Total		
	Domestic	Foregin	Total	Domestic	Foregin	Total	Domestic	Foregin	Total
1995.	0.962	1.413	2.375	0.163	0.072	0.235	1.125	1.485	2.610
2000.	0.910	4.593	5.503	0.395	1.239	1.634	1.305	5.832	7.137
2005.	1.025	5.339	6.364	0.503	3.128	3.631	1.528	8.467	9.995
2010.	1.001	5.658	6.595	0.492	3.453	3.945	1.493	9.111	10.604
2011.	1.005	6.174	7.179	0.524	3.752	4.279	1.529	9.926	11.455

Looking at a longer time period from 1995th to 2011th years, it can be seen that the growth of both individual and organized tourist arrivals is constant. War year 1995th, except very small number of the total tourist arrivals, is characterized by the almost equal number of domestic and foreign tourists. Not surprisingly, therefore, the fact that organized tourist arrivals account for only 9% of the total number of tourist arrivals and 91% are private. It is interesting that the year was a larger number of domestic tourists who have traveled organized than foreign, that after the war crisis is not repeated.

Table 4.Tourist arrivals to Croatia, according to the organization of a trip from 1995th to 2011th year, in millions [6]

	Arrivals of domestic and foreign tourists	Overnight stays of domestic and foreign tourists
1995.	0.235	1.499
2000.	1.634	11.400
2005.	3.631	20.857
2010.	3.945	20.562
2011.	4.279	21.631

The table shows a constant increase in tourist arrivals and overnight stays by domestic and foreign tourists.

Table 5.Tourist arrivals to Croatia, according to the organization of a trip from 1995th to 2011th year, in millions [7]

	1995.		2000.		2005.	
	Arrivals	Overnights	Arrivals	Overnights	Arrivals	Overnights
TOTAL	72.376	618.067	1.239.898	9.376.422	3.128.000	15.020.834
Austria	15.550	119.481	117.729	843.931	122.121	784.300
Czech Republic	9.307	83.432	215.658	1.525.513	152.200	1.022.474
France	1.108	4.533	8.103	44.563	147.509	1.043.849
Italy	8.767	57.058	176.008	1.241.187	271.716	1.850.673
Hungary	/	/	64.439	437.034	117.270	741.543
Germany	18.453	208.048	263.097	2.433.739	533.923	4.151.279
Slovakia	3.242	25.482	73.115	515.623	38.708	260.374
Slovenia	2.924	20.422	95.078	638.100	120.485	859.092
Great Britain	2.703	26.174	22.372	193.140	122.178	927.160

Table 6.Tourist arrivals to Croatia, according to the organization of a trip from 1995th to 2011th year, in millions [7]

	2010.		2011.	
	Arrivals	Overnights	Arrivals	Overnights
TOTAL	3.453.000	12.688.132	3.752.745	13.449.067
Austria	104.246	609.196	112.484	657.203
Czech Republic	125.539	886.401	169.177	1.178.812
France	96.100	634.855	95.860	647.330
Italy	186.166	1.172.010	187.424	1.173.235
Hungary	74.308	435.718	81.972	478.191
Germany	411.488	3.222.677	470.276	3.613.853
Slovakia	67.765	466.603	60.236	420.515
Slovenia	120.971	804.187	108.780	725.771
Great Britain	94.584	664.388	104.877	719.059

Broken down by country of origin in table 5 and 6 can be seen that for Croatia most important tourist generating markets are Germany, Austria, Italy, etc., generally showing a slight increase in organized tourist traffic along the whole observed period (from the 1995th until 2011.) with periodic oscillations. From the market of Germany organized traveled 44% more tourists than 2000th year, but 12% less than 2005th. It is similar to the Czech market since 2011. organized traveled 12% more tourists than 2000th year, but 9% less than 2005th year. For Croatian Tourism it is important to continue the growth of organized tourist traffic from these "atypical" markets because the strengthening of new markets reduces dependence on traditional tourist generating markets, thus ensuring the stability of the growth of organized tourism traffic. The importance of organized tourist traffic lies in the fact that longer stays are achieved than individually, as well as a fully reporting the realized turnover so there is no gray economy. When we consider the overnight stays of foreign tourists in organized tourist traffic can be seen that this number is growing all to 2005th year when it reaches its maximum and then falls to 15% for 2010. Along with the growth of the 2011th year of 8%, but the level of 2005th has not yet reached.

Table 7.The average number of days tourists stay in Croatia by months from 2005th to 2011th year [8]

The average number of days tourists stay in Croatia				
Month	2005.	2009.	2010.	2011.
I.	2,6	2,8	2,8	2,5
II.	2,6	2,3	2,3	2,2
III.	2,7	2,4	2,5	2,3
IV.	2,8	2,8	2,8	2,9
V.	3,6	3,4	3,5	3,3
VI.	4,7	5,2	4,8	4,9
VII.	6,0	6,7	6,3	6,2
VIII.	6,5	6,4	6,7	6,8
IX.	5,0	5,5	5,4	5,2
X.	3,3	3,2	3,0	3,1
XI.	2,4	2,4	2,3	2,4
XII.	2,3	2,2	2,2	2,3
Average	5,1	5,4	5,3	5,3

Guests from 10 major emitting countries in Croatia retained average six days, with the longest stay are the Russians and the Netherlands (8 days) and the shortest Italians (4 days). Unlike foreign tourists, local guests on vacation spend about 4 days. The majority of tourist traffic takes place during the summer, the peak in July and August and other months are relatively balanced. So, the number of days tourists stay visible extends to two days in the winter months 7 days in summer. These data show the extremely seasonality of Croatian tourism.

Table 8.Tourist arrivals to Croatia, according to the organization of a trip from 1995th to 2011th year, in millions [9]

	2005.	2009.	2010.	2011.
Road	95,5	94,2	93,9	93,5
By train	0,9	1,1	0,9	0,9
Plane	2,3	2,8	3,0	3,3
By boat	1,3	2,0	2,2	2,3

The majority of tourist arrivals in Croatia is realized by road, even 93.5% 2011th year, with a slight decrease in the period from 2005th to 2011th years. There is a slight increase in air travel transportation as a result of the increasing number of low-budget airlines and slight increase in organized tourist trips by foreign tourists and modernization of air transport and the introduction of new flights.

Table 9.Tourist arrivals to Croatia, according to the organization of a trip from 1995th to 2011th year, in millions [10]

	1995.	**2000.**	**2005.**	**2010.**	**2011.**	**2011./2010. (index)**
GDP (in millions of euros)	17.122	23.146	30.950	45.919	45.894	99,90
Tourism revenues (in millions of euros)	1.020,1	3.011,8	5.998,9	6.236,8	6.598,6	105,80
The share of tourism in GDP (in%)	6	13	19,4	13,6	14,4	

Implemented tourist consumption by experimental tourism account directly generates 8.5% of direct gross value added, or 8.3% of direct gross domestic product of Croatia. In the 2011th 6598.6 million in revenues was realized, which is 5% more than the year 2010th, share of tourism in GDP Croatian was the 2011th 14.4%. Revenues from tourism in Croatia increased by 2011th year compared to the previous two years, with a slight decline in 2010. comparing to 2009., demonstrating the positive trend in Croatia in the future. The share of tourism in GDP compared to the 2005th year decreased about 5% in 2009. year and had a similar level in the 2011th. It can be concluded that tourism in 2011th makes even ¼ of GDP in Croatia, which clearly shows the

importance of the tourism sector from the Croatian economy. In Greece this share is even higher - 16.5%, however in Spain is 10%, 9% in Turkey.

3. Conclusion

After analyzing the number of tourist arrivals in Croatia, the structure of foreign tourist arrivals, the structure of foreign tourist nights it can be concluded that tourism for Croatia presents tremendous opportunities. Through the analysis of tourist arrivals to Croatia shows a significant increase in tourist arrivals since 2005, but most come in their own individual package. This fact presents an opportunity to improve and increase the number of organized trips to Croatia by both domestic and foreign tour operators.

Tourist arrivals and overnight stays in Croatia organized through travel agencies and tour operators are on the rise, however, they have not yet reached their maximum. Through the analysis of foreign tourist arrivals and overnight stays in Croatia organized through travel agencies and tour operators can be seen that the largest number of tourists come from Germany. Now is the time for Croatia to turn to other markets such as Austria, France, Hungary and others. The fact that tourists generate 8.5% of direct gross value added, or 8.3% of gross domestic product for Croatia should be a sufficient motivation for further development of the Croatian tourist offer.

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HUMAN RESOURCES AS A BASIS OF HOSPITAL CARE

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Abstract
In the health care system as one of the most complex and the most vulnerable systems with an emphasis on hospital care, human resources represent the largest, most important and most expensive input. Human resources in health care include medical (doctors, nurses, technicians, other health professionals) and non-health workers (administrative, technical and assistive staff). They are marked with quality component that includes coverage, availability, competence and responsiveness.One of the priority areas of national development strategies of the Croatian health system for the period until 2020 is also the strengthening and better usage of human resources and strengthening management capacity in the health sector. Health workers are the largest and most important resource of the health system and the need to influence the share of health personnel in the total number of employees at the hospital. It is also an indication of the structure of the hospital or health institution.
One of the key indicators for the analysis of hospital care is an indicator of the structure, which includes the total number of employees in the institution according to the number of stationary bed.
Obtaining information necessary for writing this paper was carried out by studying the literature and searching the Internet.
The aim of this paper is to highlight the importance and complexity of the role of human resources in the improvement of hospital care as well as the contribution and effectiveness in the same health care system as a whole, with emphasis on the development of a comprehensive system for tracking human resources.

Keywords:
human resourses, health system, health care

1. Introduction

Hospital medical institutions as public institutions arrange with the Croatian Institute for Health Insurance specialist-advisory activities and hospital activities. To carry out the institutional health care they hereby arrange the number of hospital beds. Human resources i.e. the employees are the key resource of any organization of hospital medical institutions within which they should achieve a high level of professional development. This includes health workers and doctors and nurse, medical assistants and non-health workers including administrative, technical and support workers. Human resources as the carriers of business processes in healthcare represent an opportunity for the development of hospitals with an emphasis on better quality and productivity of hospital care.

2. Human resources in hospital health system

Hospital medical institutions are faced with a variety of structural changes as well as requirements in the health field in order to successfully manage both hospital and business processes within healthcare institutions. The same have been classified into categories given the bed capacity, scope and range of healthcare services. There are great differences among health care facilities of the same category as well as health facilities according to the number of employees. The Department of human and material resources in the health sector as part of the Croatian Institute for Public Health continuously collects and monitors data through the State Register of Health Professionals and information on all health workers and health associates and numerically administrative and technical staff according to the number of permanent employees [4].
According to the Regulations on minimum requirements in terms of space, staff and medical-technical equipment for health care (Ministry of Health of the Republic of Croatian Official Gazette 90/2004, 38/2008 and 61/2011). are defined in terms of hospital healthcare facilities must meet for each hospital activity. The same is defined by the number of health workers for each of the hospital departments.
As one of the important indicators of the status and functioning of hospitals and structure of employment health and non-health workers, the proportion of health personnel in the total number of employees at the hospital, and the number of health workers by the number of beds in 2011, as can be seen in Table no. 1[8]
Number of health workers according to the number of beds in health care facilities is an important indicator of the health activities on the basis of which one can infer the degree of the health needs and demands for health care [10].
The graphic is displayed (Figure 2) [9] and an indicator of work that relates to the share of health personnel in total employment in health care facilities (clinical centers, clinical hospital and public hospitals) in 2012, according to the

Regulations on the conditions for classification of hospitals into categories . [2]

3. Human Resources Management

Within the implementation of health policies of any hospital healthcare facilities, emphasis is placed on fostering quality in health care, strengthening the management capacity of health institutions (professional and efficient management), strengthening and better use of human resources in the health sector, the reorganization of the structure and operations of hospitals, computerization and development of e-health as well as their cooperation and enhancing cooperation with other parts of the health system [3].

Human resources play an important role in the performance of any and any processes within the hospital health system.

When we talk about existing processes, then the priority is placed on the financial operations of the hospital medical institutions and health care quality improvement.

Human resource planning within the hospital health care system of the Republic of Croatia currently takes place at the level of hospitals and is based on the number of contracted beds. The Ministry of Health of the Republic of Croatian began in 2012 on the basis of the National Strategy for the Development of Health definition process management system that will define ways to monitor and evaluate the performance of health care providers aimed at improving the position of health care workers [10].

In accordance with the analysis of the health system of the Croatian under the National Strategy for the effective management of human resources would reduce the need for new employment.

4. Conclusion

As one of the priorities for the development and improvement of the hospital or health system as a whole is to strengthen, develop and better use of human resources. The application of standards and norms in health care is necessary to analyze and plan for human resources in the framework of which should ensure the organization and functioning of hospitals.

In this respect it is important to emphasize that investment in human resources is more cost effective than investing in any other resources, particularly in terms of the quality of the organization and management of hospital care.

Monitoring and planning of human resources with a focus on the medical staff at the agreed number of beds in hospital health system will facilitate the implementation of change within the same.

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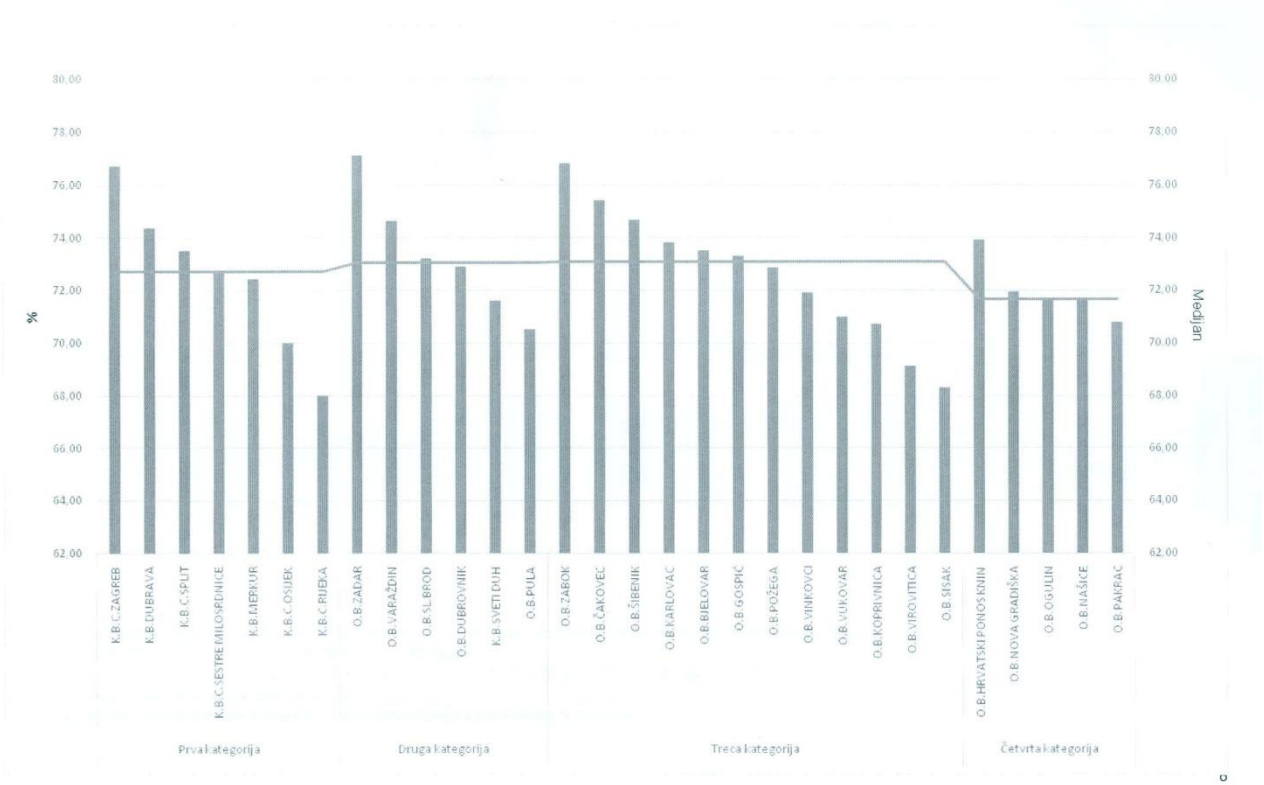
Appendix 1. Table 1. Proportion of health workers and number of health workers per bed in 2011. [8]

O.n.	Description	Total number of employees	Health workers	Non-health workers	Proportion of health workers %	Proportion of non-health workers %	Number of beds per contract	Number of employees per bed	Number of health workers per bed
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1.	Clinical Hospital Dubrava	1.864	1.384	480	74,25	25,75	600	3,11	2,31
2.	Clinical Hospital Merkur	1.127	801	326	71,07	28,93	346	3,26	2,32
3.	Clinical Hospital Sveti Duh	1.473	1.069	404	72,57	27,43	500	2,95	2,14
4.	Clinical Hospital Sestre Milosrdnice	4.132	3.044	1.088	73,67	26,33	1.412	2,93	2,16
5.	Clinical center Osijek	3.151	2.187	964	69,41	30,59	1.160	2,72	1,89
6.	Clinical center Rijeka	3.408	2.323	1.085	68,16	31,84	1.191	2,86	1,95
7.	Clinical center Split	3.100	2.204	828	71,10	26,71	1.539	2,01	1,43
8.	Clinical center Zagreb	5.220	4.066	1.154	77,89	22,11	1.905	2,74	2,13
9.	Public Hospital Bjelovar	828	598	230	72,22	27,78	337	2,46	1,77
10.	Public Hospital "Dr. Ivo Pedišić"Sisak	1.065	689	376	64,69	35,31	459	2,32	1,50
11.	Public Hospital "Dr. J. Benčević" Slav. Brod	1.220	887	333	72,70	27,30	511	2,39	1,74
12.	Public Hospital "Dr. Tomislav Bardek"Koprivnica	840	602	238	71,67	28,33	359	2,34	1,68
13.	Public Hospital Dubrovnik	863	633	230	73,35	26,65	323	2,67	1,96
14.	Public Hospital Gospić	232	168	64	72,41	27,59	104	2,23	1,62
15.	Public Hospital Hrvatski ponos Knin	256	186	70	72,66	27,34	142	1,80	1,31
16.	Public Hospital Karlovac	919	684	235	74,43	25,57	429	2,14	1,59
17.	Public Hospital Nova Gradiška	376	274	102	72,87	27,13	160	2,35	1,71
18.	Public Hospital Ogulin	316	227	89	71,84	28,16	117	2,70	1,94
19.	Public Hospital Pula	1.316	923	393	70,14	29,86	506	2,60	1,82
20.	Public Hospital Šibenik	871	644	227	73,94	26,06	296	2,94	2,18
21.	Public Hospital Varaždin	1.165	857	308	73,56	26,44	488	2,39	1,76
22.	Public Hospital Vinkovci	810	581	229	71,73	28,27	361	2,24	1,61
23.	Public Hospital Virovitica	655	449	206	68,55	31,45	300	2,18	1,50
24.	Public Hospital Vukovar	636	450	186	70,75	29,25	150	4,24	3,00
25.	Public Hospital Zabok	656	501	155	76,37	23,63	249	2,63	2,01
26.	Public Hospital Zadar	1.242	943	299	75,93	24,07	472	2,63	2,00
27.	Public Hospital Našice	416	299	117	71,88	28,13	150	2,77	1,99
28.	Public hospital Pakrac	274	190	84	69,34	30,66	115	2,38	1,65
29.	Public hospital Požega	579	427	152	73,75	26,25	250	2,32	1,71
30.	Hospital Čakovec	802	611	191	76,18	23,82	351	2,28	1,74

Appendix 2. Figure 1. Proportion of health workers in 2012. [9]



THE INFLUENCE OF STATES' DEPENDENCE ON NATURAL RESOURCES EXPLOITATION ON GDP AND GNI PER CAPITA: A COMPARATIVE STUDY

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Abstract
There is a well-known claim about the natural resource curse concerning the effect of dependence on the exploitation of natural resources to generate GDP of individual states, which exhibit a high degree of this kind of dependence. This paper examines the states with the highest share (20% or more in 2012) of total natural resources rents as % of GDP in the World and the reported figures are compared with data on economic growth as measured by GDP growth in the current U.S. $ and Gross National Income (GNI) per capita (PPP) of the same country in the period 1994-2012. From these data, the results are deduced by commenting on the impact of the high share of rents from the exploitation of natural resources in GDP on the growth of GDP and GNI per capita (PPP) of states with a high degree of natural resources rents in GDP in the period 1994-2012 and provide answers for why the level of disparity between the growth rates of GDP and GNI per capita in the period of research in one particular group of countries is higher, and in the other particular group lower.

Keywords:
resource curse, natural resources rents, economic growth, GDP, GNI per capita.

1. Introduction

"Natural resource curse" or "oil curse" can be defined as "inversely proportional ratio between a high level of dependence on exports of natural resources (oil) and rates of economic growth" (4, p. 36). This definition refers to the connection between oil and economic growth, on which many studies exist.

In researches on the connection between dependence on export of oil and economic growth, there are studies (Leite, Weidmann, 1999; Ross, 2001; Sachs, Warner, 2001; Karl, Gary, 2003; Stiglitz, 2005) indicating that this dependence has a negative impact on economic growth, as well as the studies (Birdsall, Subramanian, 2004; Alexeev, Conrad, 2009; McMillan, Rodrik, 2011) showing that high share of oil exports in GDP has a positive long term effect on economic growth. Studies (Leite, Weidmann, 1999; Ross, 2001; Sachs, Warner, 2001; Karl, Gary, 2003; Stiglitz, 2005) showing negative impact on economic growth, argue that oil brings the country dependent on the exploitation and export of oil to the stagnation. However, there are studies (Birdsall, Subramanian, 2004; Alexeev, Conrad, 2009; McMillan, Rodrik, 2011) that answer the questions about the economic conditions in countries rich in oil and dependent on its exports, if it were not for oil, i.e. would the conditions be different.

Econometric study of economic indicators in 95 countries in the period between the 1970 and 1990 (10, p. 184-188) demonstrated a clear cause and effect relationship between the degree of dependence of individual countries on natural resources export and lower economic growth rates. This research showed that the level of increase of the share of exports of natural resources in GDP from one standard deviation (deviation from the statistical average values) is associated with a reduction of slightly more than one percent in the rate of economic growth, irrespective of the indigeneity of corruption, changes in the prices of raw materials and trade liberalization. Another research (5, p. 29) places this effect on growth rate on the reduction of 0.6% and associates it only with the indirect effect of corruption. Both of these researches empirically show a link between dependence on exports of natural resources, corruption and economic performance of individual countries.

Alexeev and Conrad (1, p. 590-593) have calculated what the potential GDP per capita in oil-rich countries would be if it weren't for oil, and the result they got was that if revenues from oil would be removed from total GDP, which would thus be significantly smaller, it's shown that oil wealth does not affect the quality of national institutions. This would mean that the institutions in a country are developed or undeveloped, regardless of the wealth of oil. Results of this study oppose the claim that the oil is a "curse" and are supported by calculations, which show that, in long term, economic growth in countries dependent on exports of oil is positive. Tendency of economies dependent on export of oil is a slower growth over long periods, naturally, because of slower growth in oil production.

Despite the very different results of studies on the impact of oil on economic growth, there is a consensus among economists that deal with considerations of economic development, political economists and political scientists that high dependence on oil exploitation hinders economic development. Countries rich in oil and dependent on its export should profit more, given the extremely high income (4).

Results of the research (3), using econometric methods, show that countries whose economies are to a large extent dependent on the export of natural resources have lower foreign trade and foreign investment, the higher the level of corruption in the society, the greater the degree of inequality in a society, the less political freedom, poor educational structure of society, less domestic investment and lower financial stocks. All this refers to the comparison with countries that are less dependent on the exploitation of natural resources as a generator of their own GDP. Using the data on the rate of exports of goods and services as a percentage of GDP (1960 – 2002) and the rate of foreign investment as a percentage (1971 – 2002) in Arab countries, which are divided into two groups (members of OPEC, i.e. exporting oil and non-members of OPEC), it's shown that the members of OPEC, after a brief boom of investment in the development of the oil industry during the 1970s, have equal or lower percentage of foreign investment than non-members. In practically the same period of research (1962 – 2002), the share of exports of industrial products in total exports in oil exporting countries was constantly lower than in countries that do not export oil (3, p. 2-4). In this quantitative-based research, Gylfason actually confirmed the "curse of natural resources" in the aspect that relates to these features.

When it comes to the impact of oil rents on inequality in society, we should point out the study made by D. Malaya, T. Yogo and Mr. Timba Tatiana (6), in which they addressed the effects of oil rents on inequality, using the most recent available data on a sample of 40 developing countries. There is a non-linear (U-shaped) relationship between oil rents and inequality. Specifically, oil rent lowers inequality in the short run. This effect then diminishes over time as the oil revenues increase. Their complementary finding is that the fall in income inequality because of the increase in the oil rent is fully absorbed by the increase in corruption.

2. Method

The main goal of the research was finding the connection between high rates of dependence on natural resources and high GDP growth and significantly smaller increase in GNI per capita. The main hypothesis of the research is that the difference in increase in GDP and increase in GNI per capita is the highest in the countries that are most dependent on natural resources, with the largest increase in population and the highest level of corruption. The countries that were investigated have the highest share of total natural resources rents[4] as % of GDP in the world, and the reported figures are compared with data on the growth of GDP in current U.S.$[5], and the data on Gross National Income per capita (PPP) [6] for the period 1994 – 2012. The countries that were taken into account (32 in total) in 2012 had a total share of natural resources rents as % of GDP higher than 20% and for the period 2004 – 2012 (the second part of the study period) had recorded total share of natural resources rents as % of GDP greater than 10% for each year. Due to space limitations, paper only shows the initial year, 1994, and the last year for which figures are available, 2012. The data are shown on population trends for each country researched as well as the indexes of change for all listed indicators. The data were taken from the World Bank website. If the data were not available, they were taken for the year closest to the specified, if they were available, and if not, they were not included. From these data, the results were deduced by commenting on the impact of higher rents from the exploitation of natural resources in GDP on the growth of GDP and GNI per capita.

3. Results

Due to space limitations[7], the graphs are depicting the indexes of indicators (total natural resources rents as percentage of GDP, GDP in current U.S. $, GNI per capita, and population), which were followed for the years 1994 and 2012, in an attempt to draw the relevant conclusions.

4. Discussion

By comparing the results shown on the figures on GDP, it can be clearly seen that in the analyzed period, all the researched countries reported an increase in GDP and GNI per capita. The largest

[4] http://data.worldbank.org/indicator/NY.GDP.TOTL.RT.ZS.

[5] http://data.worldbank.org/indicator/NY.GDP.MKTP.CD/countries.

[6] http://data.worldbank.org/indicator/NY.GNP.PCAP.PP.CD/countries.

[7] For the same reason, the graphs showing the results were put at the end of the paper.

increase in GDP was recorded by country whose exploitation of natural resources came later in the period in which their price grew significantly (primarily oil), such as Equatorial Guinea and Chad or the countries that also export primarily oil since before 1990's, but had a very low production in 1994 due to internal problems (Nigeria) or have not yet activated the new sites (Azerbaijan, Kazakhstan, Turkmenistan). It should also be taken into consideration that despite the low prices at the end of the 1990's and in 2009 (due to the recession of most of the developed world), the price of natural resources (especially oil and natural gas) is significantly higher (both nominally and in real terms) than two decades ago. In addition, it was high for the most part of the first decade of the 21st century, culminating in 2008.

GNI per capita grew much less, than the GDP in all countries and some of it can be attributed to the still high population growth in most of the studied countries, as well as inflation. However, some of the countries in which this difference is most pronounced are among the most corrupt countries in the world according to the Corruption Perceptions Index (http://www.transparency.org/cpi2012/results): Equatorial Guinea, Chad, Nigeria, Gabon, Republic of Congo, Democratic Republic of Congo, Azerbaijan, and Turkmenistan. This means that a large portion of revenues from the exploitation of natural resources does not come to the widest strata of the population, but because of corruption remains in the hands of an elite team who then use that revenues, and they often do not invest in the national economy. Therefore, the GNI per capita in these countries is still low and is growing at a slower rate compared to GDP growth than in the Arab countries of the Persian Gulf which are rich in oil and/or gas. Significant exploitation of these natural resources in these countries began decades earlier, and they have managed to reduce, to a greater or lesser extent, the degree of dependence of generating its own GDP from natural resources compared to previous periods. At the same time the increase in GDP was less disproportionate to the increase in GNI per capita, although they experienced a large growth in population (mainly immigrants, mostly economic migrants who do not enjoy the benefits of higher revenues from natural resources), but they are taken as the residents when data are calculated per capita. GNI per capita in these countries was high even at the beginning of the study period. Of course, the corruption perception index in these countries, visible in the same aforementioned study, is substantially smaller than the countries of Sub-Saharan Africa and Post-Soviet Space. The results show that the export of non-renewable energy sources, primarily oil has a positive effect on the growth of GDP per capita. However, the question is how much this increase would be if there was less oil and if the degree of dependence of oil exporting countries on exporting the oil they produce was smaller, and that at the same time, the money obtained from oil revenues, was in much larger scale used to diversify the economy.

5. Conclusions

Even in developed countries, "natural resource curse" can come to the fore after the onset of significant exploitation, although developed countries are much more resilient to this "curse". There is a syndrome called "Dutch disease", which has been given such a name because of the difficulties that have engulfed the Netherlands after the discovery of gas in the North Sea. Specifically, when the state discovers oil and/or gas, the sudden influx of dollar income often leads to a strong appreciation of the domestic currency (3, p. 5). This affects the economic sectors that are not related to the exploitation of oil and / or gas, making them less competitive in the world market, thus maintaining the dominance of the activities of exploitation of hydro carbonates in the economy[8]. In the long term, resulting damage to economic growth.

In the last two decades, the most noticeable increase in GDP is in those African countries in which significant oil exploitation began in the same period (e.g., Angola, Equatorial Guinea, Republic of Congo, Chad), while in some other African countries (Libya, Algeria, Nigeria, Gabon) this significant increase in GDP was visible earlier because the exploitation started earlier, so it is smaller in the study period due to higher initial base. The effects of the increase in GDP per capita are significantly lower due to still high population growth, which was the highest in the countries (if you do not count the rich Arabian peninsula countries that have a large number of immigrants without citizenship, immigrant workers, and not due to natural population growth), which started a large exploitation of natural resources later, have a low GNI per capita and a high level of corruption perception.

Examples of countries that, despite the wealth of oil and their dependence on its exports, are successful and those that are not still show that different patterns of this dependence are important to determine the role that oil has on the political system. Where before the start of greater exploitation of oil existed structured and strong institutions (as well as other developed sectors of the economy, so that rents from natural resources

[8] The Curse of Oil: The Paradox of Plenty, *The Economist*, 20-Dec-2005, http://www.economist.com/node/5323394.

never make as high a percentage of GDP as in the countries studied here), democratic traditions and fiscal discipline (e.g. in Norway, Canada) is much less likely that the "curse of oil" would be fully developed. In large countries or stable democracies, oil can result in a positive outcome, or virtually none of the harmful structural changes. In addition, revenues from oil, which are in the periods when oil prices are high, indeed very large, in these countries are spent wisely and transparently, investing or saving for future time (for example the Norwegian Petroleum Fund), which will inevitably occur, and will be marked by the disappearance of oil. In the future, countries that are most dependent on natural resources as a means of generating GDP today, will be in the most difficult situation. They will either impoverish again or will remain poor because they will fail to raise the level of medium developed countries by the level of GDP per capita, even with high incomes from natural sources that will inevitably sooner or later disappear. It is simple as Schubert (11, p. 14) claims: "Nevertheless, sometime in a not too distant future, oil will disappear. When it does, stability will end. Those countries that have diversified will move forward. Those that do not, however, will collapse economically and politically".

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Appendix

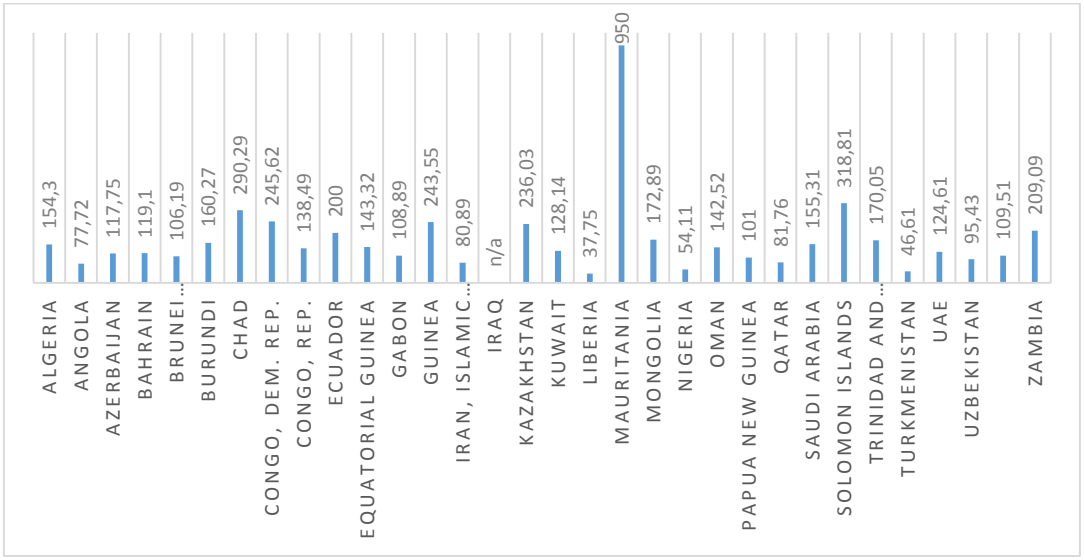

Figure 1. Total natural resources rents as % of GDP, index 2012/1994 (1994=100)

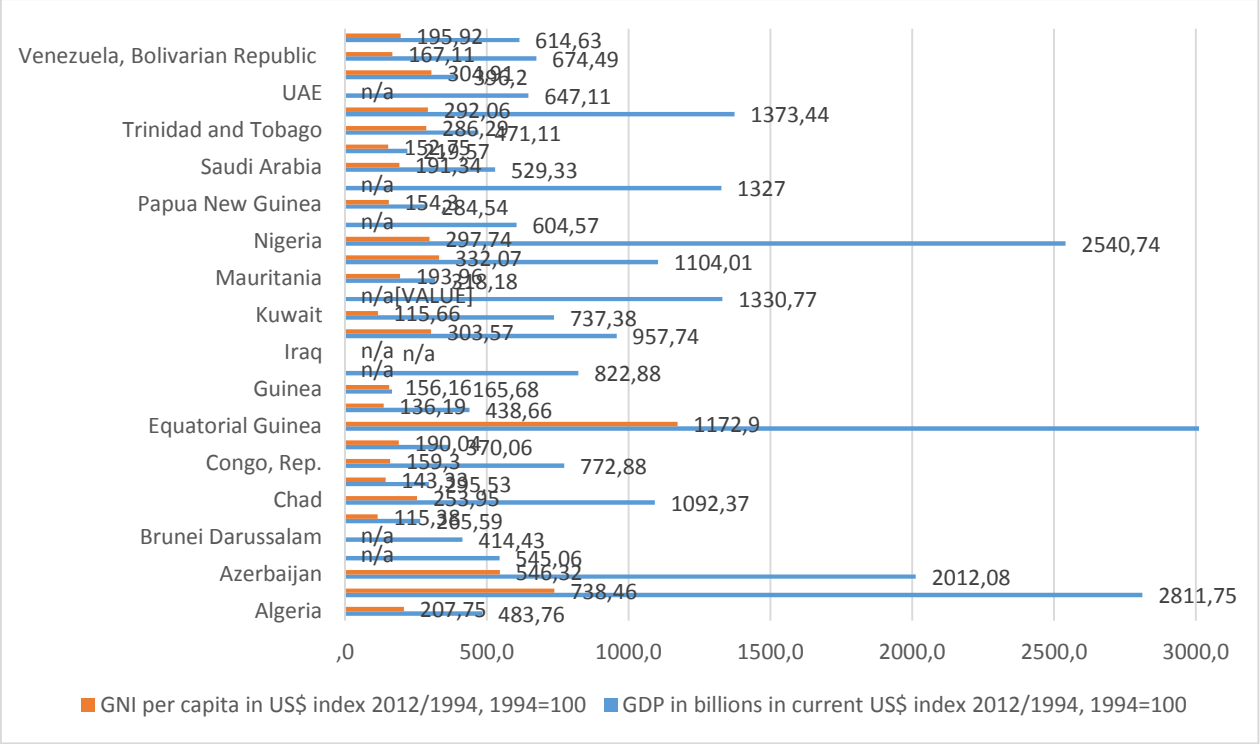

Figure 2. GDP in billions in current US$ index, 2012/1994 (1994=100)

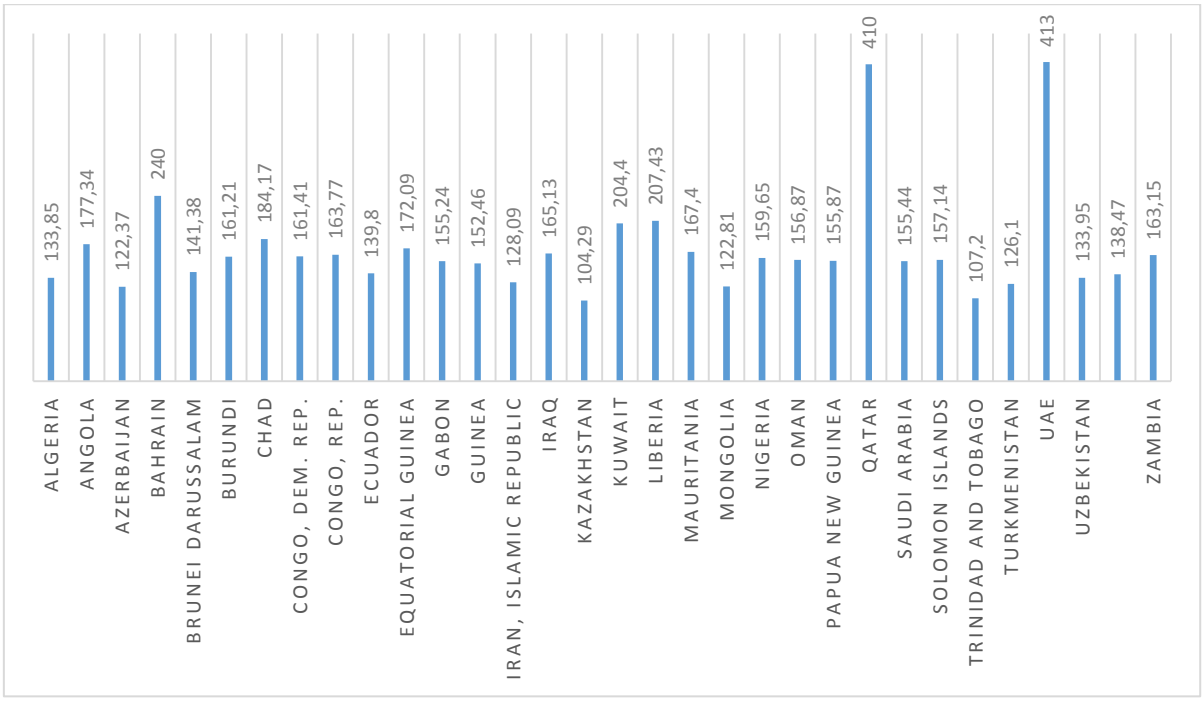

Figure 3. Population index, 2012/1994 (1994=100)

HAS THE VALUE ADDED TAX BEEN NECESSARY?

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Abstract

Value added text has been used for more then four decades and it does not represent a novelty, both in theory and practice. In modern international financial debates about tax policy there has been and there are many reasons for the usage of VAT.The most important reasons for the introduction of VAT are following:

Higher protection from tax evasion,

Higher income from consumption tax,

Achieving higher neutrality of consumption tax in relation to the consumer's choice and the decisions of producers,

Approximation of consumption tax to the final consumption of a household,

Higher neutrality in commercial transactions,

Avoidance of double taxation,

The VAT encompasses services in all stages of production and consumption,

Approaching the membership in EU where the VAT is one of mandatory conditions for EU membership. On the path to joining EU there is no alternative to the VAT, as there is no alternative, politically speaking, to joining EU for the BIH. Consequently, the introduction of VAT in the economy and the tax system of BIH was only a part of necessary fiscal reforms in BIH. The VAT with its structure and principles has an important influence on establishing order in the tax discipline, that is, the VAT should ensure equal conditions for all the participants in the trade competition. An important condition for the successful functioning of the added tax value is a functional tax administration in terms of technical infrastructure, organizational effectiveness as well as the education of employees.

Keywords:

Tax, value added tax, consumption tax, tax policy

1. Introduction

Value added tax falls into the category of taxes that are used to tax the consumption. The VAT is a multistage tax, a multistage method of taxation with which the new founded value in the stage of manifestation, sales and services, is being taxed.

The VAT is being charged only on the net added value during every sale. With the introduction of the VAT, the one stage taxation on sales and services has been replaced. Therefore, the VAD is a consumption tax, but it is multistage, while GST is a one stage tax albeit also a consumption tax. The VAD is a net added multistage tax and the GST is one stage tax. The two of them differ significantly. The VAD is paid by every participant in the chain, while the GST is paid only at the end of the sale chain; it is paid by the end consumer in the store. The VAD includes more taxpayers.

There is a control mechanism installed in the VAT system because every buyer is obliged to charge the VAD to the buyer and every buyer must pay the VAT during any acquisition. There are lower tax exemptions when the VAT is used. What the two taxes have in common is that they are both taxing the consumption; they're both regressive and more burdening on the buyers with lower income.

With certainly we can say that in the 21th century, as far as the taxation policy goes, there has been an incredble large amount of countries that have installed the value added tax (VAT). During the last twenty years the value added tax (VAT) as the main tax on consumption, has been introduced in the all members of the EU, including those that haven't done so before joining the EU, and certain countries members of OECED (Turkey, New Zealand and Australia). There are realistic chances that the same will be done with other countries, besides the USA and Australia.

A dilemma exists whether the VAT is suitable for smaller countries, with a small number of citizens as is BIH. So far the existence of the VAT in 40 smaller countries has shown positive results. In smaller countries like our own, the import is always greater than export, and there exist a zero rate of taxation, so the application of the VAT is not always suitable because of the outflow of the collected founds.

With the application of VAT in the tax system of BIH, many services have been left untaxed. Perhaps it would had been a better solution if a new tax system has been applied with entering of a new century.

2. The importance of introducing the VAT in the tax system of BIH

Introducing the value added tax in BIH, meant widening the tax base because the VAT allows for taxation in the broader sense than the formally used sales tax and service tax. A winder taxation base has made tax evasion more difficult and has probably contributed to the collected income in one

part of taxation. In addition, the application of the VAT allows for complete reduction of taxation in case of export in relation to service tax because the VAT enables the cancelation of even the hidden taxes. Furthermore, the VAT implies unique tax rate so that his effect on the relation between the prices would be neutral. Moreover, the VAT implies the increase of tax documentation for the assessment, the collection and the control of taxation. Finally, the VAT implies a complete computerization of the taxation procession in the services of the public income and better education of tax collectors[7].

The neutrality of value added tax (because of potential influence on the decisions of consumers and manufactures) implies determining the same tax rate for a large number of goods and servicers, and significantly wider tax base from the alternative sales tax. The goal of the VAT is not to disturb the relative price. Naturally, the distribution factors are very important in the sense whether the VAT is progressive, proportional or regressive type of tax. The studies of OECD prove and show that the VAT is regressive in Sweden and Denmark, proportionate in Germany and progressive in the Great Britain. If the VAT is used instead of sales tax, in retail, that takes the same income, the influence of taxation can be insignificant[5] because the pressure of the VAT on the price increase will be neutralized with the price decrease pressure because of the cancelation of goods and services tax. However, where there is a policy of social control of prices the inflationary effect is a real possibility.

The VAT is a consumption tax and it is being collected at every stage of production and distribution. In so called European Systems of Accounts (ESA), the EU economy pays for the VAT for the goods it produces, pays a tax to all suppliers of goods and services that it purchases and files a report to the Customs and Excise Department for the differences between output taxes and input taxes in every accounting period[2]. In practice it means the net payment of businessman. Tax administration seeks refund from business man, since the output tax is usually higher then the input tax. Vice versa when the output tax is higher then the input tax the businessman asks for a refund from the tax administration. According to that, the VAT generated incomes are collected in the every stage of production and distribution, so that in the end they are equivalent to that what is paid in full by the final consumer. The deduction of the input tax in its stage ensures that the sales tax is not being paid.

In theory and practice the prevailing opinion is that the VAT is actually a value added tax and that the burden of the taxation increases during the process of production and distribution until it is levelled with the amount that it is paid by the end consumer in the retail. That implies that the VAT is paid in advance and that it puts a special burden in form of interests on the companies that precede the retail stage in the chain[1]. In the economic sense, the added value is simply the difference between the selling and buying, irrespective of the fact whether the buying and the selling are connected, that is the difference between the price of products and expenses that have been paid to the third party for the supply of what is needed to produce goods. Tax is being paid for any purchase of goods that increases supply but no tax is being paid in the production of goods that haven't been sold yet. It is at the same time 'a deception and a confusion' that is being resonated in the way mentioned above. From the other hand, the taxation experts believe that TVA is not a tax on added value but a technical manner in which the collection of overall tax, which is paid by the consumer in retail, is being diffused trough the entire industry and trade[3].

The VAT, a tax that exists in the countries that are members of EU, although it has similarities with the retail sales tax, is characterized by something that makes it superior. Namely, the most important differences in favour of the VAT are to be seen : in the fact that the VAT automatically differences between commodity and the produced goods (even when it is the same goods), that it doesn't demand the identification of customers, that it doesn't lead to cumulative effect, that it unites the treatment of services and goods, that it leads to a bigger economical neutrality and to more equal distribution of the tax burden, that is imposes an equivalent substitute tax to import, on the principle of destination, that equalizes the tax burden of domestic and foreign goods.

In writing the VAT is usually illustrated with an example that explains the trace of a production of a typing machine. In that context, Cnosses says: 'Following the process of production and distribution, we start with a miner that sells the iron stone to ironworks that delivers the steel to the manufacturer that sells the typing machine to the wholesale, that then delivers it to me'[5]. Added value of the typing machine grows at every stage. So, does the selling price. In retail, as a final stage, the sum of all added values (200 euros) is the same as the selling price without the tax (200euros). That shows that the VAT is a multistage tax that is being paid on the sale in every stage of production and distribution including the retail stage. Now the deduction for taxes is being given to companies for the tax that they had paid in acquiring the manufacturing goods from the manufactures. A pledge for the additional deduction of tax is the tax that will be paid during

purchase. That means that the value added tax is limited to additional value so there would not be accumulation of it in every stage.
In contrast to VAT the services and goods tax is one stage tax that is being paid only once for every good in the moment when the good passes into the hands of the user or buyer (consumer). Here the tax achieves its neutrality trough the suspension rules[7].
The value added tax is not characterized by the possibility of different tax rates, because it is extremely difficult to install tax benefits and deductions in all the stages of production and trade. Accordingly, from the viewpoint of managing an active social policy, one stage services and goods tax is more suitable than the VAT that is why it probably functions in the countries members of EU. On the other hand, model service and goods tax doesn't include any means from manufactures and sellers, as tax payers, because it is being paid after its collection at sale that is service. However, with the value added tax, paying taxes engages the funds of the manufacturer that as a tax payer in fact credits the treasury until the tax refund that had been collected in the stages until the final forming of tax liability. Moreover, the sales tax is a bit cheaper from the VAT from the means of expenses of tax collection; and the smaller number of employees is involved in the calculation of tax (especially because no record about acquiring and sales is needed, nor the complicated bookkeeping about the business, the calculation of base and the tax refund). Finally, with the sales tax there are fewer possibilities of tax evasion than with VAT and it doesn't require such high expertise from the administration staff as the VAT does. Transmission is assumed function of one stage function goods and sales tax (located in the phase of retail) because it influences the price of the product indirectly. Without transmission the sales tax would burden the manufacturer that is seller. Consequently, our sales tax would basically become income tax. That would happen on a perfect marker because the sales tax would burden the manufacturer because of the completely elastic demand. The increase of the selling price because of the sales tax returns like a boomerang to the manufacturer that is the seller. With the substitution of product, the buyers avoid the fiscal impact over prices. The same is the case with non elastic offers.
'Besides basic elasticity of offer and demand for the explanation of effects of sales taxes over prices on the relationship of offer and demand, the elasticity of product substitution is also important. Furthermore, since the sales tax affects all buyers i.e. consumers equally (regardless of their tendency to consumption and their purchasing power). Different income groups respond differently to price increase under the influence of sales tax.
That is why the income elasticity of consumers is also important for the analysis of tax effects, in addition to already mentioned substitution elasticity for certain products and the price elasticity of offer and demand [5].
On the market all the consumers (buyers) are anonymous and with an unidentified economy power. By that fact alone, the taxpayer is unknown during the measurement of tax commitment. Following the pyramid of income, the sales tax equally affects those with low, middle and higher income. That is why it is, from a social point of view, regressive; no matter if it is the first or fourth Engels law (the share of paid expenses on nutrition in the personal consumption is being reduced with the increase in income- income elasticity lower than one; share of expenses on education, culture and hygiene is being increased with the rise in income- income elasticity higher than one.) Selective fiscal policy tries mostly to soften the regressive effect of sales tax, whether by lowering the tax rate on products that are of vital importance for the standard of living and by increasing taxes rates on luxury products, whether by totally freeing certain consumer's goods from taxation. Expendable type of value added tax has a singe benefit in contrast to one stage sales tax. That advantage is evident with the tax treatment of entrepreneur's petroleum products. In fact, taxing of petroleum products, regardless of whether they are used for the end production or reproduction has a cumulative effect. The same is the case with the private entrepreneur's in small businesses that are raising means for the reproduction in the status of the end consumer and pay sales tax. Entrepreneurs are in a worse economic position then the social sector that is practically being freed from taxation of all production funds. In contrast to our sales tax, the value added tax means taxation exception for overall expenses and net investments.
The value added tax, in addition to several already stated benefits in contrast to multistage goods and services tax, has additional benefits such as: it is beneficial for the producers, it doesn't narrow trade competition and division of labour, it doesn't cause the fall in taxes, and it doesn't negate its neutrality on the number of the respective stage. The value added tax includes only the net value of all participants in the chain and not only the net value of the final one, as is the case with goods and services tax with transmission on the buyer that is the consumer.

3. Conclusion

There is no alternative to the VAT on the path to EU, as there is no alternative, politically speaking, to joining EU for BIH. The introduction of VAD in the economy and the tax system of BIH has been only a part of necessary fiscal reforms in BIH. The VAD with its structure and principles has an important influence on establishing order in the tax discipline, that is, the VAD should ensure equal conditions for all the participants in the competition on the market. It was because of its many benefits that the VAD has been introduced in many countries in the last forty years. In the countries where the VAD is the main source of public income lives over 70% of world population, over four billion residents.

However, the success of the fiscal reform doesn't depend only on the legal regulations. For the success of fiscal reform in BIH very important factors are:

1. The attitude of politicians and politically influential people
2. The public attitude
3. The training of those involved in the implementation of certain fiscal solutions.

If we were, with a distance of over twenty years, to analyse the weaknesses of the earlier services and goods tax, we would quickly come to the conclusion that the SGT and sales tax depended on and were changed by the political attitude that others were stealing from us, from our people and our entrepreneurs and that the taxes are going to the political centres of power where they are being distributed to the people with connections. It is possible that the certain remarks made sense. Perhaps it would be enough only to distribute the GST rate to state (that would be collected by the central state and entities), county (that would be directly collected and used by the counties) and local (that would be used by the units of local government- municipalities). In this type of sales tax affiliation, the tax discipline would be greater and better because within it all actors of financial obligation would be involved, regardless of their position. For the weaknesses of fiscal system in BIH the blame is not be found in the tax stages and rates but in the acceptation of a fiscal system and putting it in action by the individuals, political leaders and the public. For that we need the all inclusive education of everyone. The government, the state and the state budget are considered to be a compulsion and an expense in this area, but we must find mechanisms by which it will be acceptable that it is an expense of public interest. If we had already had that, than the sales tax system would had worked fine for us, but it we do not have that and we do not, than the VAT system will not work for us, nor will it help us leave recession and decrease the poverty into which we are sinking deeper and deeper. The conclusion is: we might have done with the GST and sales tax. We need the VAT. We had to accept the VAT because the more powerful ones are requesting it. We need before anything else, a social state that we will all embrace as our own. We need taxes and budgets that will reduce poverty and social injustice. This means we have a lot to change and accept (firstly Scandinavian models and solutions) what the west is offering to us so that we could defeat poverty and start a life of prosperity and dignity for everyone.

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IMAGE AS A CAREER DEVELOPMENT COMPONENT OF A MANAGER

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Abstract
This period of tumultuous changes, which we are faced with, especially the ones ahead of us, will convey many new characteristics of earning, two of which are essential in this approach: the transformation of inherited system of negotiated (with politics) economy into a truly social market economy; and change in the relation of owner of capital – company – company management (management board). A common feature of these, and many other changes, is that the companies will be able to respond to them only with qualified, creative, talented and enterprising managers with a fully formed image. The capitalists, who have been created by our privatization and politically established wild capitalism, are not managers of the future. Their image is false; it is a farce and a reflection of daily politics.
The changes will require manager to be complete personality, who, in addition to its professional qualities, possesses a number of psychological dimensions of high quality such as: established and solid stands consistent with the stand of the working environment, high motivation and enthusiasm, communication skills as well as fully formed personal image in the he company and its surroundings. The manager will need to possess fully built psychological dimension of its personality. The need for quantitative testing and image monitoring of each manager will no longer be highlighted as "idle gossip of psychologists in enterprises", but primarily as an essential component and the variable that managers need, in order to establish themselves as successful entrepreneurs and executives. In this paper I have tried to present the part of the testing, believing firmly in their relevance in the forthcoming financial reality.

Keywords:
manager, career, image, agent

1. Introduction

In semantic and conceptual meaning the term "image" often means a lot. The meaning of the term “image” can be translated as "picture", "perception", "notion" or "impression". All these concepts as much as somewhat indicate the meaning of the term image, they are just its constituent components, regardless of whether the image of an object or a person.
Starting from the widespread and conventional understanding of the term, the image can be said, represents an integral set of principles, ideas, impressions and perceptions that a particular person has about an object or another person.
Each person has its own image and it is, in a way, a collection of various symbolic meanings, impressions and beliefs related to that person. As a rule, the image will affect the place of the individual in a society, and especially in its working and living environment.
The image of one manager is a prerequisite for its personal, but also the overall business performance of the enterprise. The up-to-date manager does not live in isolation, and is constantly under the scrutiny of social and environmental reality. The modern manager constantly works on improvement in public relations as it is a specific component of manager's image. It is common to see top experts fail to succeed as executives, which points, moreover, to the fact that the image is also consisted of different unreal and irrational elements, replicated from work environment and wider social environment. That's why it is said that there are seven types of managers’ image: image of the country, of the companies, institutional image, and function-linked image, image of the article / the service and personal image. Image is also a dynamic category, subjected to the influence of time and change. The image of yesterday’s manager is often reduced to a worn, old and untidy suit. Having that style one cannot enter the new business world of market economy, entrepreneurship and private and personal initiative.Many of our former leaders have spent their entire working lives and never done something useful on their own initiative. Majority of todays’ directors of public companies act in the same way. They are, and have often been, just ordinary, obedient executors of numerous ideas set by dominant governing system. Since they have been recognized as trusted and indispensable, presented as God-given personnel, their “image”, which comes “from above”, depends on the implementation of various political directives and attitudes. They are always "extremely busy," while their whole life, basically passes in endless,

empty and exhausting meetings, which often lack in thematic content. They are award-winning Managers of the Year, of the region etc, awarded by the ones “from above” who decide on everything, and all is "in the interest of one’s own people."

Such managers change their jobs as worn-out suits, while the army of young professionals wait and vainly visit numerous offices and "local image-makers' expecting to get the chance to work.

The modern manager will not only be unable to clown through their entire working live, but will suffer consequences if the given opportunity is gambled away. Beside required expertise and business shrewdness, a modern manager will have to constantly take into account the many elements of his own image, which he will acquire at the workplace, street, conferences, forums, seminars and other educational activities. Given the past performance of our companies, there has been no testing and monitoring the image of directors but there were some exceptions to the rules, however, in certain circumstances. The reasons are many, and we'll list just a few:

a) In the absence of a clear position on the ownership of capital, there was not specifically stated motivation and interest in the characteristics of executives to whom the capital was entrusted to manage.

b) Decisions for the selection of some executives, especially the general managers of the companies, usually come from the ruling parties, so that the real carriers of the image (workers and experts) can only slightly influence the selection. Therefore the actual image of such a manager has mainly a minor significance in the choice of candidate for managing position.

c) Firms are lacking the personnel who would be able to successfully implement image monitoring. Only a few companies have employed psychologists, but they had been engaged with various other matters (testing of employed workers, creating the schedule for workers, dealing with social problems, conflict situations, etc.) so they couldn’t deal with systematic monitoring and testing of image.

d) If "ad hoc" image testing was organized somewhere, difficulties would arise in the implementation and acceptance of test results for some more effective purposes. Since it is about testing the people who have a certain status and power, not rarely, the leader of such tests, and the results obtained, would face organized resistance.

In this paper, we present an experimental example of manager’s image analysis, trying to give at least a symbolic contribution to this extremely complex and valuable but neglected segment in the theory and practice of business management.

2. Object and methodology of the research on two managers

It is the image research on two managers/ field sales agents in two companies. Shortly said, we wanted to determine whether the two managers obtain a positive or negative image in their managerial practices and communication within the team and the market. Our efforts were to find out which elements their image is constructed from, and what is the analytical value of these elements and the overall image?

On two occasions we have examined 200 subjects by using the methodology of quota sample. 50 respondents were from the teams in which these sales managers work and the remaining 100 respondents were from sales area. All of these subjects were the people who often (almost daily) communicate with above mentioned managers.

In this research we decided to use the methodology of semantic differential as one of the most popular methods to measure the connotative meaning of image, motives, attitudes and similar psychological categories. We tried as much as possible to avoid subjectivity in the evaluation, but also to get as much valuable analytical data as possible. Semantic differential really makes it possible.

The first step was to identify the basic elements of the image of an "abstract" manager. All respondents were asked the same question, which was: „In your opinion, what qualities one successful sales manager should have?". We have classified respondents' answers such as "needs to be resourceful” in a scale of relevant concepts and their associated negative meanings (in this case "resourceful-unresourceful"). Therefore we got bipolar scales that represented image defining elements.

Surveyed respondents were presented a multitude of associations (42 sequences in total), which prompted us to exclude all associations and meanings that didn’t have their representative value. To determine semantic differential, we considered only those associations that are listed in at least 173 out of the total number of respondents.

It has been found that it is twelve bipolar connoted scales:

a) resourceful - unresourceful
b) competent - incompetent
c) kind - unkind
d) professional - amateur
e) self-initiative - inert
f) persistent - complying
g) ambitious - unambitious
h) reliable - unreliable
i) patient - impatient
j) communicative - uncommunicative
k) authoritative - obidient
l) neat – dowdy

In the second phase, respondents are offered to assess the twelve scales: „Please select which of the proposed terms are corresponding to sales agent A. Also, try to rate the selection by using the numbers listed next to all terms i.e. next to term "resourceful" choose 3 or other".

We have given the same text to the respondents connected to sales agent B. The remaining 100 respondents were asked to "evaluate" both field sales agents individually.

The scales are offered in a somewhat modified form, in a way that the scale of a positive term such as "resourceful - unresourceful" was followed with the scale with a negative one, such as "incompetent - competent." We did this in order to, at least partially, avoid automatism and possible superficiality in the evaluation that would occur if the positive side of all twelve scales followed, as often happens in practice.

The both agents were introduced with the results assuming that it would be of use for them in order to correct the mistakes in the fields where negative or positive associations were present, below the average value of image. But, at the same time, at positively connoted symbols, the agents would make some improvements in order those symbols to achieve certain stability or to make progress towards more positive value connotations.

Two years after the first testing and image defining, we performed a second research on the same sampling, using the same methodology in order to register some ascending curve differential as a reflection of the time and the activities undertaken by the two agents in developing their own image, according to findings from the first test. We expected that such progress would be seen in the courses of directions and (or)the intensity of some associations far more than it might be assumed that, in a relatively short time, the significant ascending of the entire curve would take place, for all twelve monitored association of image. In the process of image defining we noticed some methodological difficulties, which in a certain way can affect the results. These are primarily agents' experiences in sales management, organizational structure of the company and sales departments which the agents manage, etc. Although the difference in leadership experience in sales is about four years in favour of the agent "A", the experience as one of the elements of image development can often have significant impact. Likewise, the organizational structure of the company may influence the perception about some manager, whether it is about his well-developed or flawed organizational skills in the company as a whole, which also reflects on the sale itself. As much as these and other, previously developed, image researches are useful and necessary, we believe that, having in mind the character and purpose of this work, as well as its space limitations, it is not possible to realistically present it.

3. Results for discussion and conclusion

The charts (1-4) are presenting average value curves of semantic differentials of image connected to agents A and B, according to estimates that are registered in their teams, and at the markets where they operate.

The results have been grouped in a way that we, with initially registered differentials in the company and in the market, and individually for each agent, have presented the curves of differentials registered during the time, which we call "development" differentials.

In addition to each chart we have given the basic characteristics of each scale on the curve: the arithmetic mean (<), standard deviation (u), and the coefficient of variation (v).

According to the estimates of the respondents in the company, Agent A is in the first testing connoted moderately positive as resourceful, competent, kind, reliable and neat, while agent is slightly worse evaluated in the scales of self-initiative and patience. The agent is connoted to be more complying than persistent. In the second testing, two years after, the average value of all the associations of the agent's image is increased from 2.5 to 2.7, as shown in Chart no. 7.

However, the very flow of the growing differential curve, of tentatively called "partial" image, is somewhat more balanced in the flows of respondents' association. This time the respondents' associativity is raised in the trends: self-initiative, persistent, patient, communicative and neat, while in other trends there is no visible change regarding strengthening the positive image among workers in the company.

Table 1: The initial average value curve in semantic differential of agent A image according to the ratings of respondents in the company (solid line: A Ipo) and the developed initial value curve of the same term (dashed line: A Ip)[the authors']

$A\ I_{t0}$			$A\ I_{t1}$		
4,0	**1,9**	**47,5**	**3,0**	**0,4**	**13,3**
3,0	**2,8**	**93,3**	**3,0**	**1,6**	**53,3**
2,0	**I,0**	**50,0**	**4,0**	**3,0**	**75,0**
3,0	**2,2**	**73,3**	**2,0**	**1,1**	**55,0**
2,0	**0,8**	**40,0**	**1,0**	**0,6**	**60,0**
3,0	**2,5**	**83,3**	**4,0**	**0,8**	**20,0**
4,0	**3,4**	**85,0**	**3,0**	**2,5**	**83,3**
3,0	**2,1**	**70,0**	**4,0**	**2,2**	**55,0**
2,0	**1,1**	**55,0**	**1,0**	**0,3**	**30,0**
4,0	**1,3**	**32,5**	**2,0**	**1,4**	**70,0**
3,0	**2,0**	**66,7**	**2,0**	**0,8**	**40,0**
3,0	**1,0**	**33,3**	**4,0**	**2,8**	**70,0**

Table 2 shows the average value curves of the initial and developed Semantic Differential of the

same manager according to the ratings given by the respondents at the market (A and A It0 It1).
In the first testing this group of respondents characterized agent A as a persistent (average scale value is 3.0) as opposed to the evaluation of the same term given by the workers within the company (the average score is zero). It is similar in connotation to the term "communicative", where the average score is 4.0 compared to the first group with a score of 2.0.

Table 2. The initial average value curve in semantic differential of agent A image according to the ratings of respondents at the marker (solid line: A Ipo), and the developed initial value curve of the same term (dashed line: A IP1) [the authors']

A I_{p0}			A I_{p1}		
3,0	2,2	73,3	4,0	1,7	42,5
3,0	2,0	66,7	3,0	1,4	46,7
2,0	0,9	45,0	I,0	0,4	40,0
4,0	1,6	40,0	3,0	0,9	30,0
1,0	0,2	20,0	3,0	1,6	53,3
-	-	-	2,0	1,0	50,0
4,0	2,8	70,0	3,0	2,9	96,7
3,0	2,2	73,3	1,0	0,8	80,0
1,0	0,4	40,0	3,0	1,9	63,3
2,0	0,9	45,0	3,0	2,4	80,0
4,0	1,7	42,5	2,0	0,6	30,0
3,0	2,0	66,7	4,0	1,0	25,0

Table 3.The initial average value curve in semantic differential of agent B image according to the ratings of respondents in the company (solid line: B IPO), and the developed initial value curve of the same term (dashed line: BIp1) [the authors']

2,0	1,2	60,0	2,0	0,4	20,0
3,0	0,6	20,0	4,0	0,8	20,0
3,0	0,8	26,7	2,0	1,1	55,0
2,0	1,1	55,0	4,0	0,6	15,0
3,0	I,4	46,7	3,0	0,4	13,3
4,0	1,3	32,5	5,0	2,3	46,0
4,0	0,9	22,5	3,0	1,9	63,3
2,0	1,9	95,0	4,0	2,1	52,5
2,0	0,7	35,0	3,0	0,4	13,3
4,0	I.4	35,0	4,0	0,6	15,0
3,0	1,5	50,0	4,0	1,1	27,5
3,0	0,8	26,7	5,0	2,4	48,0

Developmental curve of semantic differential AI indicates that there was a shift of positive associations of partial image so that it is now more “kind "(increase from 2.0, which was the initial, to 4.0). This association has a significantly higher rating compared to the development one that we have registered with agent A IP1 (average of 1.0). In development associations A It1 some associations as "persistent" (average of 4.0) and "confidential" (average 4.0) are higher compared to the same associations in the development semantic differentials A IP1.

Table 4. The initial average value curve in semantic differential of agent B image according to the ratings of respondents at the market (solid line:BIt0), and the developed initial value curve of the same term (dashed line: BIt1) [the authors']

B I_{t0}			B I_{t1}		
1,0	0,4	10,0	1,0	0,9	90,0
2,0	1,1	55,0	3,0	2,2	73,3
2,0	0,6	30,0	3,0	1,1	36,7
3,0	1,5	50,0	3,0	0,6	20,0
2,0	1,7	85,0	3,0	1,1	36,7
2,0	0,8	10,0	1,0	1,9	47,5
3,0	0,6	20,0	3,0	2,6	86,7
3,0	2,3	76,7	1,0	0,5	12,5
2,0	1,9	95,0	3,0	2,1	80,0
2,0	1,1	70,0	3,0	2,0	66,7
3,0	0,9	30,0	2,0	0,8	40,0
2,0	1,3	65,0	3,0	0,6	20,0

In the initial registration of partial image in the company Agent B (B Ip0) is determined, with average evaluations, as: competent, kind, self-initiative, authoritative and neat. In associations with the terms such us persistent, ambitious and communicative agent B received an average value of all associations 4.0 - highly expressed positive values.
In overall observed value of all the twelve semantic differential scales the agent B is slightly better evaluated than the agent "A" (2.9 versus 2.5).
From the flow of line differential B Ip0 it can be visually concluded that the agent B image is more stable that the initial image of the agent A, that is A Ip0.
Moreover, in the curve A Ip0 we observe that next to the dispersed flows between the individual associations there are some slightly approaching positive flows. In contrast to the slight difference in the average values of all 12 semantic scales of the agent "A" (A Ip0 = 25, and A IP1 = 2.7), the agent B ratio is more favourable in favour of the developing partial image. The average value of all the associations in the differential B Ip is 0 2.9, and in the development differentials B IP1 is 3.6. This is evident in the Figure 3[4] but also in the visual monitoring of the curve B IP1.
Namely, in the second testing agent B is emphasized to be more: competent, professional, reliable, communicative and authoritative while the most value is connected to persistence and neatness as the image symbols.
By the scores of respondents in the market, the partial image increase is present also between the two analyses. With 2.3 (which was the average value of the curve B It0) to 2.9 (average value of the curve B It1). This increase was not recognised as it is the case with the respondents in the company (B IP1 B Ip0).
In relation to the associative flow of the first testing (B It0), the developmental curve B It1 showed a more significant positive shift only in the notion of

"neat" (from 2.0 to 4.0), while almost all the others terms were without some major and significant change.

Based on these results of partial image it could be concluded that the partial image on the market is quite clearly and stably defined in its direction and intensity. That cannot be said for the part of the manager's total image that exists within his company, because it is evident that even its development is still in progress, which is reflected through the individual projections of associations and through the increase of their values that we have presented by curves B and B Ip0 relation. In the overall image analysis is not enough just to monitor flows of associations at the direction and intensity. It is necessary to also analyse the significant differences between individual scales, especially when it is repeated in two or more consecutive tests.

With agent B there is no clear deviations so we can talk about a steady course of development of the overall image (Tab. 3 and 4), which is not the case for the agent A (Tab. 1 and 2).

It would be interesting, through further researches, to determine why the inconsistencies within the associations in curves A Ip0 and AIP1 are significant, especially between "ambitious", "professional", "authoritative" (average score 4.0) and "self-initiative", "persistent", "patient" (with low average scores). This comes from the need for diagnostic image processing in order to obtain real insight and opportunities to shape a better overall image.

Image monitoring and registering has its corresponding strategic importance. We have already pointed out that the created image is one of the essential prerequisites for success in managing the organization. Therefore, this awareness should be used in creating an appropriate strategy to improve or maintain the present position.

In Fig 1[4], we tried to give a basic indication and strategic directions for the image development and also to label "critical" areas where the odds are small in the creation of a significant image. Based on this knowledge, and based on the results of this research in Fig.3., it is possible to develop one's own image that we show in Figure 2.[4] in Fig 3. we tried to position the overall image of the sales managers "A" and "B".

The overall image of the manager "A" shows a slight shifting tendency within the company and the market, according to the image of medium intensity. Considering the manager "B" direction of movement, the overall image position is slightly more favourable in flow with an emphasized rising trend.

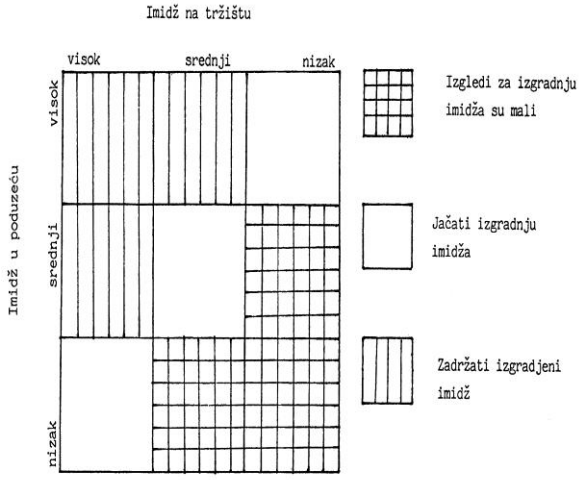

Figure 1. Strategic positioning of the image values in management

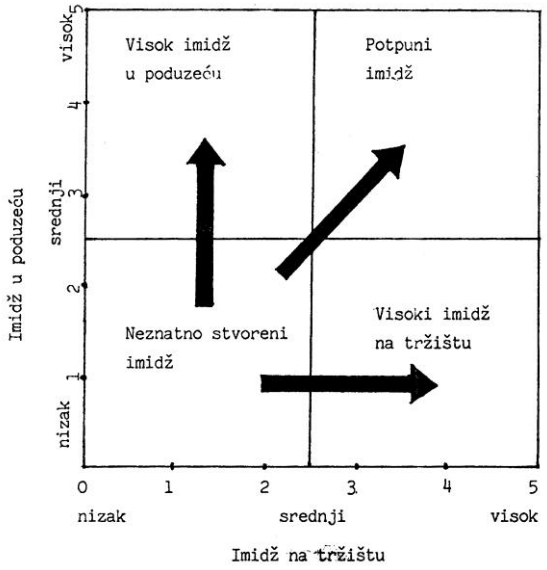

Figure 2. Developing a positive image

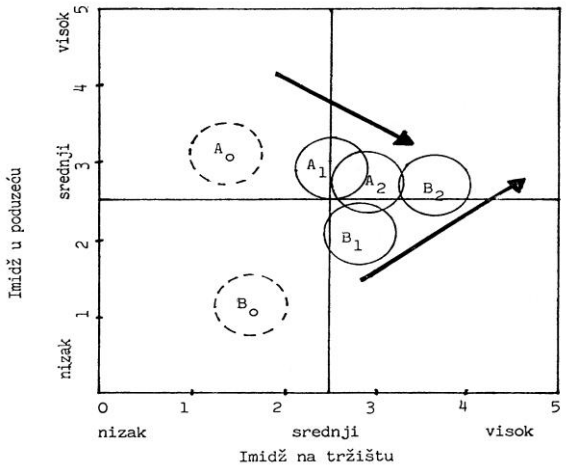

Figure 3.The development of image manager A.i B.

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PRICE-SENSITIVE EXAMINATIONS OF TRADITIONAL PRODUCTS

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Abstract

Price strategy is a peculiar aspect of the marketing model called Marketing Mix. Pricing related decisions usually constitute the hardest and most sensitive set of decisions that entrepreneurs have to make. The Hungarian consumers' high price sensitivity coupled with a high demand for low-cost products and services indicates the significance of pricing in Hungary. Pricing is crucial in raising interest and winning new customers. Prices might reflect product quality, brand strength and recognition, just like product differentiation or the image of a product or its producer. Consumers of traditional region-specific horticultural and agricultural products are willing to pay a higher price in appreciation of the high quality and special character of these products as this consumer segment tends to assign emotional functions to certain product features instead of solely focusing on the functionality and usefulness of the goods.

Keywords:

price setting, pricing strategy, customer-perception

1. Introduction

Throughout history, prices have usually been determined between the sellers and buyers in price negotiations (bargains). Traditionally, consumer decisions and purchase decision making processes largely depend on price. However, non–price factors, e.g. product features, place of origin, communication, have been gaining significance in purchasing decisions over the past decades. Of all the aspects of the Marketing Mix, price is the most flexible one and it is the only one which creates sales revenue [1]. Excessively cost-determined prices or failure to frequently analyse and vet pricing, thus promptly respond to changing conditions on the market are just a few of the most common mistakes, which are, in a broader context, the symptoms of ignoring the importance of treating price as part of the positioning strategy, hence setting a price that does not complement the other elements of the Marketing Mix [2].

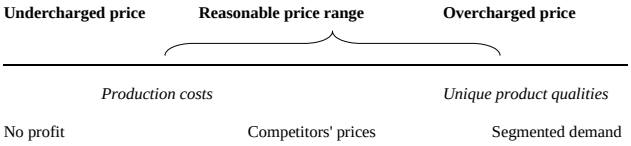

Figure 1. Replacement product prices

No single economically or psychologically well based price setting method can be established for traditional and region-specific foodstuffs due to the heterogeneity of the subject product group [3].

2. Material and Method

Market research: the opinion survey refers to information collection, whereby a small section of a group of numerous individuals or institutions is selected via professional sampling and this selected section is then interviewed.

The primary market research consists of the gathering of original, previously uncollected information and data, whereby the collection is undertaken with a specific purpose. I sought the answer to various questions during recording, therefore each answer can be registered as a variable as they can take varying values within a certain number interval. These are the dependent variables because, depending on the respondents, the result will be different, too. The questions (variables) remain the same throughout the questionnaire and the interviewees (respondents) are referred to as cases.

Paired t-test analysis. For paired t-tests, the same respondents are tested repeatedly, thus test series are conducted on the same respondents and the paired t-test is used to examine the differences. A variable for the differences observable in the pair is created (marked as D) and then the average and variance of this variable is calculated. Subsequently, the t-statistics is established. The degree of freedom is “n-1”, where “n” stands for the even number of the examinations [4].

*Pearson’s Chi-squared test.*The exact significance test is based on two hypotheses; one is referred to as null hypothesis and the other is as alternative hypothesis, respectively [5]. The Chi-squared test uses the following formula:

$$X^2 = \sum_{i=1}^{2}\sum_{j=1}^{2}\frac{\left(f_{ij} - e_{ij}\right)^2}{e_{ij}} \quad (1)$$

Confidence interval calculation. During the evaluation of questionnaires, representing the results simply in percentages is often insufficient or even misleading, given that the resulting differences do not reflect reliably whether the variation is significant or not. The answers to the particular questions in the examined population helped me identify both the percentage of the positive answers and their confidence-intervals, the latter values revealing the real differences. The calculation of the confidence-intervals is inevitable for the establishment of a reliable conclusion on our hypotheses, especially in cases where the number of sample elements significantly differs.

3. Assessment of the importance of price for traditional region-specific foodstuffs

Purchasing decisions are seldom resolute; consumers are exposed to a certain level of risk in the purchase decision making process. The perception of the risk depends on the consumers' personality, the nature of the product or service and predominantly on the price. Our research investigates the consumers' perception of the price of traditional region-specific foodstuffs.

The respondents have been segmented on the basis of their sex (Fig.2), age (Fig. 3) and educational attainment (Fig. 4) in order to examine whether the different segments respond differently. Price obviously plays a key role in the purchase decision making processes; and as the products in the focus of our research are special quality ones, many consumers perceive their prices as a reflection of their heightened quality.

Table 1. Title of the Table

Independent Samples Test		t-test for Equality of Means						
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Conf Int of the Diff	
							Lower	Upper
Criteria Selection PRICE	Equal var assumed	0,456	398	**0,649**	0,043	0,095	-0,143	0,229
	Equal var not assumed	0,457	396,93	0,648	0,043	0,094	-0,142	0,228

Chi-Square Tests	Value	df	Asymp.Sig. (2-sided)
Pearson Chi-Square	**3,447[a]**	**4**	**0,486**
Likelihood Ratio	3,545	4	0,471
Linear-by-Linear Association	0,208	1	0,648

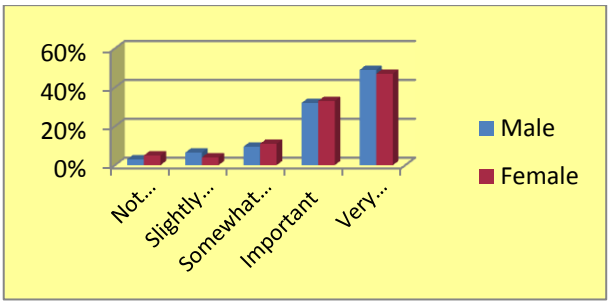

Figure 2. Assessment of the importance of price by gender

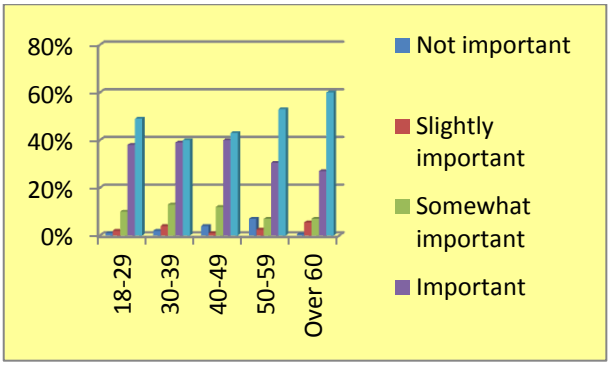

Figure 3. Assessment of the importance of price by age group

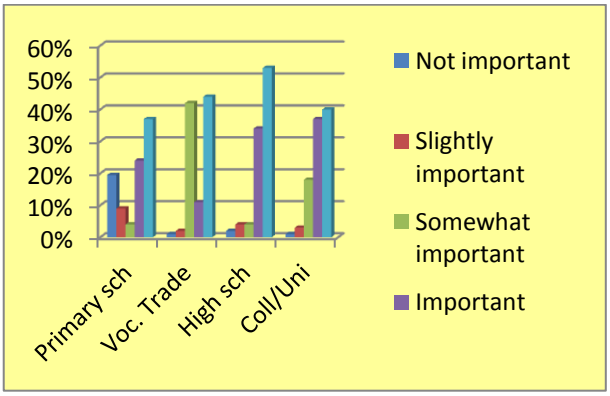

Figure. 4. Assessment of the importance of price by educational attainment

The findings of our research are on the system of values and preferences that seem to determine foodstuff purchases. Apparently, the influential factors for female customers are the price and product mix, whereas male customers seem to primarily focus on the producer; however, members of both sexes mainly find the price „tolerable".

Willingness to pay extra for Hungarian foodstuffs. The research examines and assesses the willingness to pay extra for Hungarian products. Seven mathematical and statistical analysis methods have been deployed to evaluate the responses (Fig. 5. and Fig. 6). Generally, the respondents are willing to pay extra solely for certain products and Hungarian foodstuffs that are perceived as prestige goods constitute such

exceptions. There might be a correlation here with the fact that the main target group of these Hungarian products is customers who are more affluent than the average Hungarian consumers.

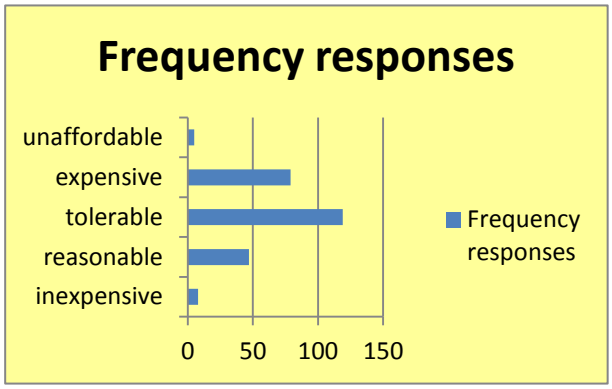

Figure 5. Assessment of the price of Hungarian foodstuffs

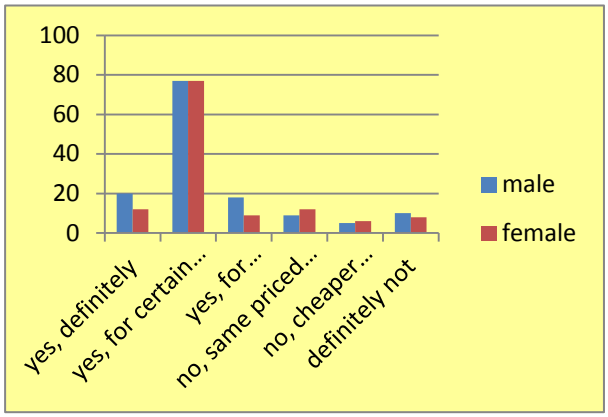

Figure 5. Willingness to pay extra for Hungarian foodstuffs

4. Conclusions

Agri-food industry is an immensely diverse and colourful sector in Hungary. The specific ecological conditions in Hungary enable the cultivation of special high quality agricultural products. Only safe and high quality products with added value can meet the high international quality standards. The natural and social values of the traditional region-specific products have great market potential; the optimal exploitation of this potential, however, requires the enhancement of the competitiveness of these products as well as the intensification of the marketing activities that help the products enter the market and preserve their positions there. Price strategy is a peculiar aspect of the marketing model called Marketing Mix. Pricing related decisions usually constitute the hardest and most sensitive set of decisions that entrepreneurs have to make. The Hungarian consumers' high price sensitivity coupled with a high demand for low-cost products and services indicates the significance of pricing in Hungary. Pricing is crucial in raising interest and winning new customers. Prices might reflect product quality, brand strength and recognition, just like product differentiation or the image of a product or its producer.

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ANALYSIS OF INTERNET BANKING IN PRACTICE OF CROATIAN BANKS

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Abstract
The authors analyse and compare Internet banking, mobile banking and telephone banking in the example of three Croatian banks. The aim of this paper is to investigate, analyse and compare data on these services banks through several parameters: the number of users, service offerings, and the fee for a given service in Internet banking, mobile banking and telephone banking. Ultimately, the authors conclude which of the service is the cheapest and which has lower fees than those in conventional banking, which is the reason for the constant growth of its customers.

Keywords:
banks, services, Internet banking, mobile banking, telephone banking

1. Introduction

Banks are all those financial institutions that offer the widest range of financial services, primarily credit, savings and payment services and have the widest range of financial functions of any business firms in the economy [1].
A credit institution is a legal entity that is from the competent authority received approval to operate, and whose business is to receive deposits or other repayable funds from the public and to grant credits for its own account [1].
Activity banks occurs as a result of the exchange of surplus goods which means gearbox functions of banks, and the development of commodity-money relations generated cash surpluses (depository functions). Placing these funds by the forerunner bankers developed the credit function of banks [2].

2. Functions of banks and banking operations

The most important functions of banks are the following: [1]
- depository; development institute "depositum irregular" seeks the return of only a portion of deposits which the depositor entrusted the depositary enabling the depositary that this part has deposits in the form of loans,
- credit; commercial banks perform the function of financial intermediaries collecting deposits and offering them in the form of loans,
- payment function; this function performs the bank based on deposits as requested by the depositor where the bank will make the payment usually through money transfer, and less in cash,
- mediation function in payments; including payment services at home and abroad,
- function preservation value; initially they were real deposits, and later failed. This function is considered to be one of the oldest and influenced the development of banking,
- function of hedging; the bank under its structure, principles of business and management skills protect against risks to its customers,
- policy functions; banks are the most important form of the transmission mechanism of monetary policy and their actions directed towards the goal of ensuring stability in the financial and economic system,
- brokerage functions; bank this function is performed by offering investment services in the securities,
- commissioners' functions; applicable to asset management (the trust jobs),
- functions of cash; bank, according to the principles of banking operations, manage surplus cash of their clients,
- function of money creation and multiplication of deposits and
- function of the securities.

Based on its function, the banks operate as companies on the principles of liquidity, safety and profitability with the aim of making a profit. The objectives of the banks as a joint stock company are: maximizing shareholder value, perform basic functions and achieve social goals. Like the goals and operations of banks are different in character.
There are several different division of banking operations, depending on the principles, but the most common and most widely accepted division of banking operations is a division of the balance sheet-analytical criteria.
In accordance with this criterion banking operations are divided into: [1]
- passive banking operations
- active banking operations,
- intermediary (neutral) banking operations and
- own banking operations.

In active banking operations the bank is acting as creditors. These jobs along passive banking operations are the basis of the banking business,

and the most developed and economically and financially most important active banking operations is lending.
Passive banking operations are also called business resources. By maturity, can be short term or long term, and the bank is acting as the debtor. The most common include accepting deposits.
Intermediary (neutral) banking operations are also called commission activities, because the bank is acting as commission agents or where the work done is taken the agreed fee that commission. Intermediary banking activities include: [1]
- brokerage in payment transactions,
- preservation and management values (Depot operations),
- purchase and mediation in securities etc.

Own banking operations are those jobs that the bank performs in its own name and for its own account with the aim of make a profit. Common tasks include arbitration and stock speculation, and rarely occur in the form of industrial enterprises or participating in joint stock companies.
In addition to basic banking services for the profitable operation of each bank are very important and its services as well as forms of payment.

3. Modern forms of payment

Traditional forms of payment (bills of exchange, checks, cash, etc.) The development of society and technology is increasingly changing to faster adapt to the lifestyle and needs of clients.
Therefore, in today's modern forms of payment include card and electronic payment.
An important feature of the card is to enable clients to manage the funds that they have in the account, but also to achieve through card debt. The cards replace cash, provide convenient and secure access to funds in the account, provide the ability to pay and the possibility of deferred payments, the ability to pay the costs in instalments, allow purchase worldwide (payment via the Internet, phone, email, etc.). The cards are usually divided into: debit cards, credit cards, cost cards, and prepaid cards. [3]
Most modern forms of payment include electronic payment. If the data transfer takes place without the circulation of documents, based on computer communications, global communications networks or public telecommunications networks, then such payment can be defined as an electronic payment. Secure electronic payment must provide: privacy, user identification, message integrity, and Irrefutability completed transactions [3].
For the purpose of modernization of operations and reduce costs, the bank their business increasingly conducted via the Internet. The advantages of online banking are large for the bank and for clients. Enable customers to quickly and easily perform daily financial transactions, while not having to wait in line at the outlets and banks enabled significant reduction in material and operating costs.
Most banks via the Internet allow performing all forms of banking. Bank accounts via the Internet: make time deposits, gain credits, perform payment transactions, to buy shares in the fund maintained by a bank, to receive notifications of changes to the account balances and other information related to the client's banking, communicate with a personal banker, carry out currency transactions and etc. [3].
While all categories of banking operations as possible via the Internet, many services are limited, which is particularly applicable to business with loans. Through the Internet generally are granted short-term loans that have a clearly defined duration and interest rate, but they do not approve short-term loans or loans for the purchase of durable goods. For such loans are still required traditional ways of financing through written requests.
Internet businesses, banks reduced their material costs and open new channels of revenue from fees that enable them to provide quality services to Internet banking.

4. A comparative analysis of Internet banking in the case of three banks in the Republic of Croatia

Internet banking in three Croatian banks (Zagrebačka banka d.d. (ZABA), Privredna banka Zagreb d.d. (PBZ), Erste & Steiermärkische banka d.d.) has been analyzed by several parameters (number of users, service offerings, and the fee for a given service in Internet banking, mobile banking and telephone banking). Table 1 shows the number of users of Internet and mobile banking and banking services via a fixed telephone in the Republic of Croatia in the period from 2009 to 2013.

Table 1. Number of users [4]

Year	Internet banking	Mobile banking	Fixed telephone line
2009	559.711	209.358	239.858
2010	665.444	290.654	218.128
2011	732.929	315.266	203.794
2012	948.068	350.895	219.784
2013	1.040.373	443.708	219.491

Based on the data in the table is possible to observe that Internet banking most commonly used form of banking industry in relation to the other two forms. Internet banking every year, a growth of users, while banking via the fixed telephone users only decreased in 2013 compared to the number of users in 2012, but in comparison

to other years. Mobile banking in 2013 doubled the number of users compared to 2009.
Table 2 shows the Internet banking service for all three researched banks.

Table 2. Internet banking services [5,6,7]

Service	ZABA	PBZ	ERSTE
Control of regular payments	Yes	Yes	Yes
Review of completed orders	Yes	Yes	Yes
A look at current and giro accounts	Yes	Yes	Yes
An insight into information about standing orders	Yes	Yes	No
Checking loans and credit cards	Yes	Yes	Yes
Transfer money to other accounts at the bank and beyond	Yes	Yes	Yes
Buying and selling of foreign currencies	Yes	Yes	Yes
Trade and transfer of shares in investment funds banks	Yes	Yes	Yes
Repayment of the loan in the bank	Yes	Yes	Yes
Arranging a standing order	Yes	Yes	No

The data in Table 2 show that all three selected banks through Internet banking offer a range of basic services which can no longer be used by traditional banking and thus facilitate the operations of a large number of clients. While Zagrebačka banka d.d. and Privredna banka Zagreb d.d. offer the same package of basic services, with some services specific to individual banks, Erste banka d.d. offers fewer services. For instance, does not offer the possibility of standing orders via Internet banking, offering a small number of services in the category of special banks (eg. contracting insurance, housing savings etc.).
Mobile banking allows banks to customers via smartphones have direct access to banking services.
Table 3 presents the mobile banking services in the three banks.
Based on the data in the table is possible to observe that mobile banking offers a small number of services than Internet banking, but still enough to be able to easily manage accounts, perform overhead expenses and other bills, buy and sell foreign currencies and etc.

Table 3. Mobile banking services [5,6,7]

Service	ZABA	PBZ	ERSTE
Checking all accounts	Yes	Yes	Yes
Overhead expenses	Yes	Yes	Yes
Order entry with execution in the future	Yes	Yes	No
Payments of part of the bank loan	Yes	Yes	Yes
Trading in shares in investment funds	Yes	No	No
Buying and selling of foreign currencies	No	Yes	No
Buying GSM vouchers	Yes	Yes	Yes
Exchange rate list	Yes	Yes	Yes

All three banks are offering the option of paying bills and checking account through this service, but there are some differences in services. Privredna banka Zagreb d.d. and Erste banka d.d. does not offer the option of trading in money market funds and the ability to sell foreign currency, while Erste banka d.d. does not offer the possibility to enter orders with future dated payments.
Telephone banking is a much smaller number of users of Internet banking and mobile banking. Telephone banking is the beginning of Internet banking, therefore, might expect to offer a smaller number of providers of Internet banking and mobile banking.
Table 4 shows the number of telephone banking services for all three selected banks.

Table 4. Telephone banking services [5,6,7]

Service	ZABA	PBZ	ERSTE
Checking all accounts	Yes	Yes	Yes
Overhead expenses	Yes	Yes	Yes
Transfer funds to bank accounts	Yes	Yes	Yes
The transfer of funds to accounts outside the bank	Yes	No	Yes
Payments of part of the bank loan	No	Yes	No

Telephone banking offers a limited range of services, while the package of services at different banks.
Privredna banka Zagreb d.d. does not offer the ability to transfer funds from their bank account into another account outside the bank, but it is the only one that offers the option of paying the loan through telephone banking, as the other two banks do not offer. Another disadvantage is the time limit of one part of services. For all financial transactions such as the Zagrebačka banka d.d., the client is a limited-time bank, and for everything else to serve his telephone answering machine through which can find out the status of all your

accounts and credit cards. With such a limited selection of services and restrictions on hours of certain services, it is not surprising that of all forms of banking, telephone banking has the smallest number of users.
Table 5 shows the fees for arranging Internet banking services.

Table 5. Fees for arranging Internet banking services [5,6,7]

Bank	Fee for contracting services	Monthly fee
ZABA	No fee	10.00 HRK
PBZ	45.00 HRK once	8.00 HRK
ERSTE	No fee	8.00 HRK

Based on the data it can be concluded that Erste banka d.d. is most favourable for fees contract with Internet banking, while Privredna banka Zagreb d.d. is unfavourable with the highest fee for contracting the services of 45.00 HRK.
As for the monthly membership fee that is unfavourable Zagrebačka banka d.d. with a monthly fee of 10.00 HRK, while the other two banks have a fee of 8.00 HRK per month. Ultimately, it is possible to conclude that the fees for arranging services and the lowest monthly membership at Erste banka d.d., which the client paid only a monthly fee of 8.00 HRK.
Table 6 shows the fees for issuing the authorization device in all three banks.

Table 6. Fees for issuing the authorization device [5,6,7]

Bank	Fee for issuing the authorization device
ZABA	100.00 HRK once
PBZ	No fee
ERSTE	No fee

When it comes to issuing authorization device, Zagrebačka banka d.d. is unfavourable because of the issuance of its token users charged 100.00 HRK.
Packets of other two banks do not provide compensation for authorization device.
Table 7 shows the fees for arranging services of mobile banking.

Table 7. Fees for arranging services of mobile banking [5,6,7]

Bank	Fee for contracting services	Monthly fee
ZABA	No fee	10.00 HRK
PBZ	No fee	8.00 HRK
ERSTE	No fee	8.00 HRK

All three banks have provided for charging a fee for arranging mobile banking, but charge a monthly fee for using the service. Monthly membership fees for Erste banka d.d. and Privredna banka Zagreb d.d. amounts to 8.00 HRK per month, while fees for Zagrebačka banka d.d. is 10.00 HRK per month and is less favourable than the other two banks.
Table 8 shows the fees for transactions in mobile banking.

Table 8. Fees for transactions in mobile banking [5,6,7]

Bank	Payment in favour of natural persons in the bank	Payment in favour of business at the bank	Kuna payments to accounts outside the bank
ZABA	No fee	1.00 HRK	2.00 HRK
PBZ	No fee	1.00 HRK	2.00 HRK
ERSTE	No fee	1.00 HRK	2.00 HRK

Based on the data in the table it can be concluded that all three banks have the same fees for payment in all three categories, but they charge the same as in Internet banking.
Table 9 shows the fees for arranging telephone banking services.

Table 9. Fees for arranging telephone banking services [5,6,7]

Bank	Fee for contracting services	Monthly fee
ZABA	No fee	10.00 HRK
PBZ	No fee	6.00 HRK
ERSTE	No fee	8.00 HRK

Compensation for contracting services free of charge, none of the banks, while the price of monthly membership fee is different depending on the bank. When paying monthly membership fee is advantageous Privredna banka Zagreb d.d., while the maximum fee charged Zagrebačka banka d.d.
Table 10 shows the transaction fees in phone banking for all three selected banks.

Table 10. Transaction fees in phone banking

Bank	Payment in favour of natural persons in the bank	Payment in favour of business at the bank	Kuna payments to accounts outside the bank
ZABA	No fee	2.00 HRK	3.00 HRK
PBZ	0.5% of the amount, at least 2.50 HRK, maximum 50.00 HRK	0.5% of the amount, at least 2.50 HRK, maximum 50.00 HRK	The bank does not offer this option
ERSTE	No fee	2.50 HRK	3.50 HRK

For users of telephone banking services is advantageous Zagrebačka banka d.d. which offers

compensation in a fixed amount of 2.00 HRK for payment on account of business entities in the bank, and for accounts outside the bank fee of 3.00 HRK, while Privredna banka Zagreb d.d. offers a suite of negative 0.5% for the amount of payment, while not offering payments to accounts outside the bank.

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5. Conclusion

Number of users of Internet banking in Croatia in the last five years has doubled. It talks about accessibility, convenience and benefits of Internet banking compared to conventional banking. The number of mobile banking users is also growing, but the figure in relation to Internet banking is small. The reason for the constant growth of users of Internet banking, among others, is the number of services that banks offer.

Mobile banking on the other side offers customers a small number of providers of Internet banking, but the advantage is that it is more mobile and can perform tasks anywhere, and fees for paying bills are the same as for Internet banking.

Telephone banking can be considered an outdated form of banking and in comparison to the two forms is less favourable. Is limited-time bank, with more fees and commissions from mobile and Internet banking.

Ultimately, it is possible to conclude that the Internet banking is future of banking. Allows clients instant access account, money management, paying bills with low fees and access at any time of the day. The advantage for the bank is that it reduces material and operating costs, and open new channels of revenue from fees that enable the provision of quality services to Internet banking.

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MECHANICAL ENGINEERING

MAIN RESULTS OF 50 YEARS RESEARCHES IN THE FIELD OF GEAR TRANSMISSIONS MANUFACTURING

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Abstract
In this paper I present the main results of theoretically and practically researches oriented for developing the modern gear transmissions. Practically researches were made at UM.Cugir, TEHTRANS Oradea, UNIO Satu-Mare and NEPTUN Campina factories. In these activities I developed the following main transmissions: helical pumps and compressors, DUPLEX and CAVEX worms, special worm hobs, environmental gearing , profile modified gears, CNC hobbing and grinding of gears. The theoretically researches was made at T.U.Cluj-Napoca Department of Manufacturing Engineering.

Keywords:
Gearing, gears transmissions, gear manufacturing.

1. Introduction

After finished the university studies, I started the industrial activities in Mechanical Factory from Cugir (RO), where I studied and realized a lot of new gears transmission and needed tools. After 7 years I continued my activities in T.U.Cluj-Napoca, where in cooperation with Professor Maros.D. was made a lot of theoretically and applicative researches in the field of manufacturing the special gears.

2. Developing the manufacturing technology of the first Romanian helicoidally pumps

In cooperation with professor D.Maros, we developed the geometry and technology of helicoidallyal pumps (fig.1) and compressors which was manufactured firstly in Romania.

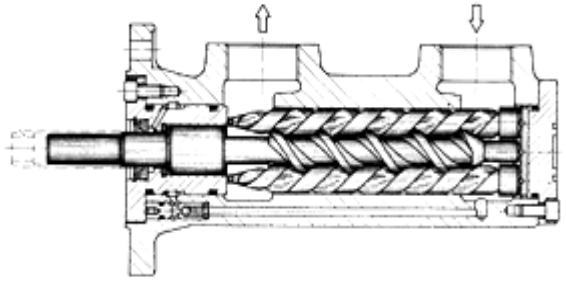

Figure 1. Axial section of helicoidally pump

We analyzed the theoretically and two modified variants(fig.2). For variant 2, b the equations of axial reciprocally enveloping surfaces are :

$$x = 2R\sin(\alpha' + \varphi) - (R + f)\sin(\alpha + 2\varphi),$$
$$z = 2R\cos(\alpha' + \varphi) - (R + f)\cos(\alpha + 2\varphi) \quad (1)$$

For practically manufacturing we analyzed two variants (fig.3).

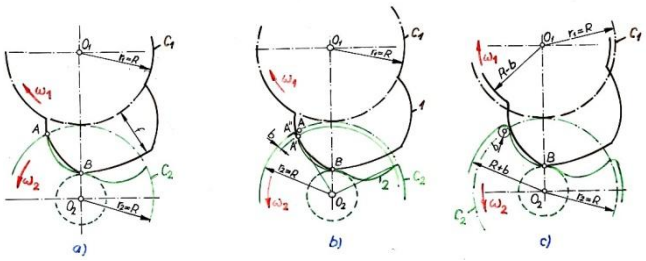

Figure 2. Different variants of reciprocal enveloping curves of helicoidally pumps

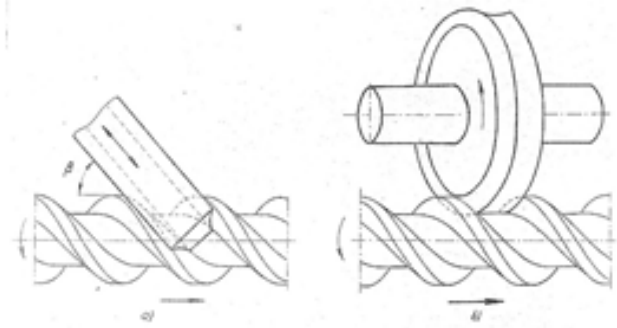

Figure 3. Two possibilities of manufacturing by meshing of helicoidal pump parts

For disc type tools the relative position of coordinate systems can see on figure 4. The equations of relative normal's are :

$$n_x = h\left[(r_1 + r_2)\sin(\alpha + \varphi + \nu) - \left(1 + \frac{r_1}{r_2}\right)(r_2 - a)\sin\left(\alpha + \frac{r_1}{r_2}\varphi + \varphi + \nu\right)\right], \quad (2)$$
$$n_y = \frac{r_1}{r_2}(r_2 - a)(r_1 + r)\sin\frac{r_1}{r_2}\varphi,$$
$$n_z = h\left[(r_1 + r_2)\cos(\alpha + \varphi + \nu) - \left(1 + \frac{r_1}{r_2}\right)(r_2 - a)\cos\left(\alpha + \frac{r_1}{r_2}\varphi + \varphi + \nu\right)\right]$$

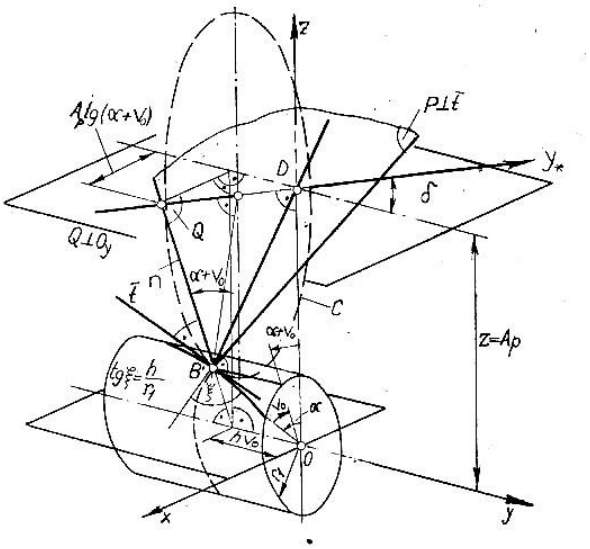

Figure 4. Determination of relative enveloping surfaces in the case of manufacturing the helicoidally pump parts with profiled disc tools

The realised complex tools for these pumps can see on figure 5

Figure 5. The tools materialized on the base of the developed methodology

3. Accurate calculation of worm hobs functional geometry and new method for optimization of lateral active clearance angles.

It is well known that in the case of the worm hob, one of the difficult problems is the wear of cutting edges, which are mainly due to the inappropriate lateral clearance angle. In order to accurate calculation of this angle we developed a new methodology based on accurate theoretically and practical study.

Based on the figure 6 , we define the constructive lateral clearance angel α_l as the angle between the normal $\overline{N_0}$ at the spatial imaginary envelope surface and normal $\overline{N_\alpha}$ to the lateral surface of the tool, in any point of the cutting edge.

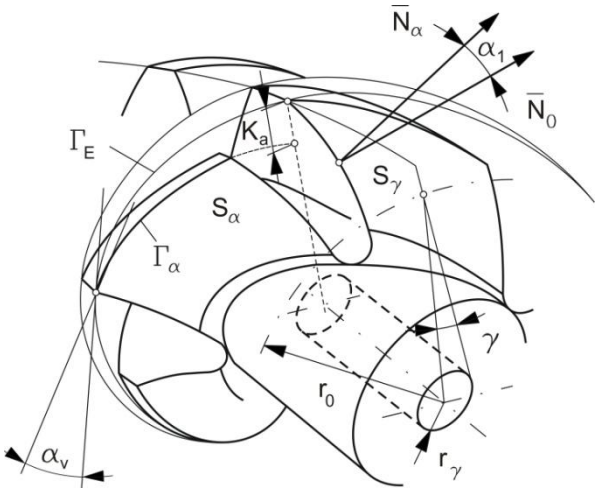

Figure 6. The constructive geometry of worm-hob

The functional lateral clearance angel, was define like the complement of the spatial angel between the normal $\overline{N_\alpha}$ and relative speed, from the cutting process. (fig. 7)

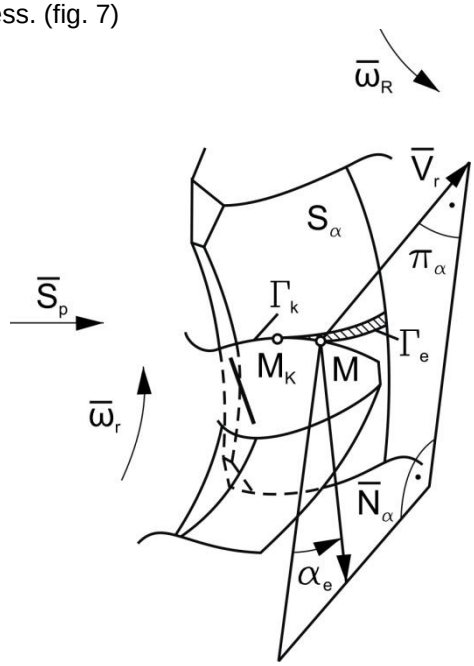

Figure 7. The active lateral clearance angle

In order to accurate determination of *the constructive lateral clearance angel*, we use of cutting triangular planes of generating cutting process with worm-hob (fig. 8).Using the previsions definition:

$$\alpha_l = \arccos \frac{\overline{N_0}.\overline{N_\alpha}}{\left|\overline{N_0}\right|.\left|\overline{N_\alpha}\right|} \qquad (3)$$

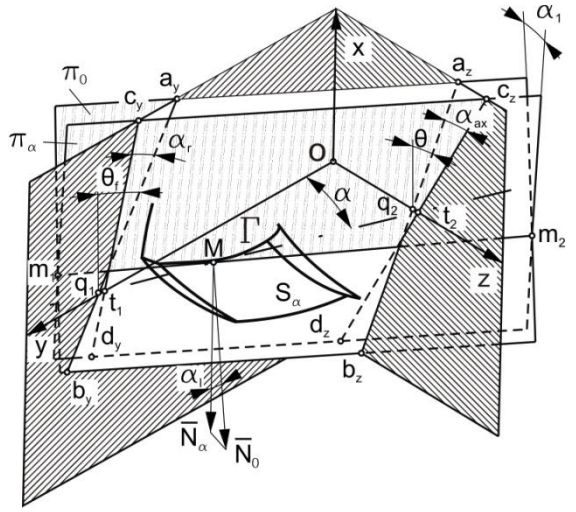

Figure 8. The characteristic triangular planes of generating cutting processes

In order to accurate determination of *functional (active) lateral clearance angle*, we must to analyze the relative motions from gear cutting processes by generation (fig.9).

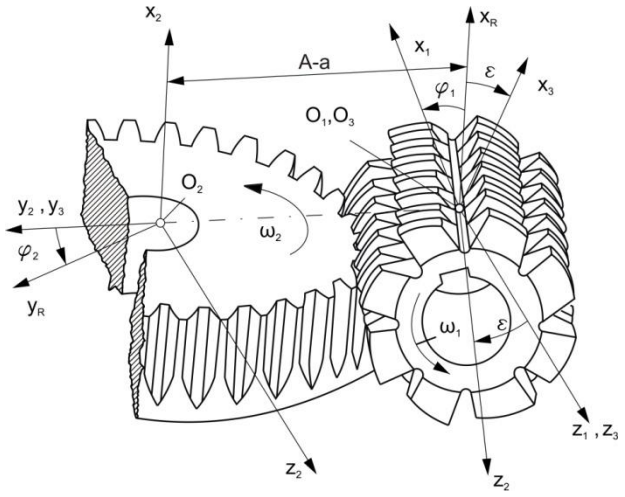

Figure 9. Relative position and movement between worm-hob gear in the cutting processes

Using the matrix methodology (after Litvin), the relative speed can be calculated with equation the following equation:

$$\overline{v_r} = \begin{Bmatrix} (A - a - y_1)\sin\varepsilon + e_{ax}.n_p \\ x_1 \sin\varepsilon + (z_1 - h\varphi_1)\cos\varepsilon \\ (A - a - y_1)\cos\varepsilon + h.i_{12} \\ 0 \end{Bmatrix} \quad (4)$$

where: with x_1, y_1, z_1, there are marked the coordinates of the certain *M* point, from the enveloping helicoidally surfaces;

- e_{ax} – axial feed , mm/wrew
- *h* – helical motion parameter, mm/rad;
- *a* – cutting depth, mm;
- ε - angle of worm-hob axis inclination.

In this way, the active *lateral clearance angle can be* determinate with expression:

$$\alpha_{le} = \arcsin \frac{\overline{N_\alpha}.\overline{v_r}}{|\overline{N_\alpha}|.|\overline{v_r}|} \quad (5)$$

4. Using the Frenet's trihedron for study of helicoidally surface technologies

It is known that the most commonly used procedure for helicoidally surfaces finishing is their grinding. The successes of these depend at wheel axis correct adjustment. Only the ZI involutes worm gears can be grind with planar front surface of tool. Traditional definition of the adjustment parameters leads to quite complicated and not always correct results.

I proved my theoretically that the grinding wheel axles must be oriented on direction of binormal at base cylinder's helix line of worm.(fig.10).

The direction cosines of this vector are:

$$\cos\lambda_x = \frac{r_b}{r_0}\sin\theta_b ; \cos\lambda_y = \frac{\sqrt{r_0^2 - r_b^2}}{r_0}\sin\theta_b ; \cos\lambda_z = \cos\theta_b \quad (6)$$

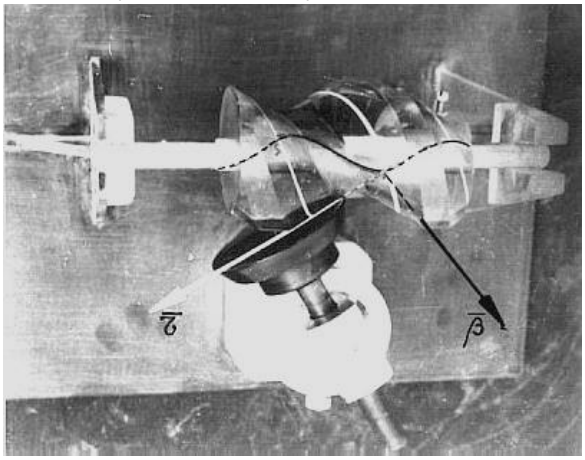

Figure 10.The binormal of base cylinder's helix line and the ZE worm surfaces manufacturing tool axe

5. New Methods for technology Development of high quality worm hobs

In order to increase the performance of worm gears used in various industrial field it is necessary the continuous development of the computational and design methods, as well as the manufacturing and control techniques. Of curse, the complexity of problems leads to a correlation between design, technology and control.

In order to determine the relative speed is considered relative position of the technological

system elements from figure 11 and was used the matrix method of **Litvin**.

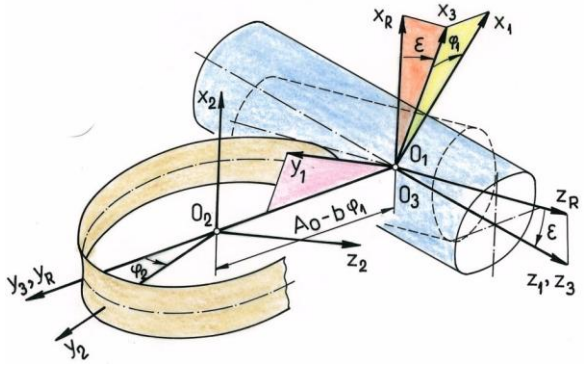

Figure 11. The relative position of the *cylindrical helicoid of the worm hob and* worm wheel in relative motion during processing.

The relative speed between virtual enveloping surfaces in rotation with angular velocity ϖ_1, and the worm wheel rotating with angular velocity ϖ_2 and radial feed movement s_R is:

$$\underline{\underline{v}}_{12} = \begin{Vmatrix} [(A_0 - b\varphi_1)\cos\varphi_1 - y_1]\sin\varepsilon - z_1\sin\varphi_1\cos\varepsilon + (y_1 - b\sin\varphi_1)i_{12} \\ [(A_0 - b\varphi_1)\sin\varphi_1 + x_1]\sin\varepsilon + z_1\cos\varphi_1\cos\varepsilon - (y_1 - b\sin\varphi_1)i_{12} \\ (A_0 - b\varphi_1 + x_1\sin\varphi_1 - y_1 c\cos\varphi_1)\cos\varepsilon \\ 0 \end{Vmatrix} \quad (7)$$

The relative speed determined by this algorithm can be use in the computing processes of high precision hobs, optimization of cutting parameters and accurate definition of active lateral relief angle.
It is well-known the fact that manufacturing of performant worm gears imposes the use of highly-accurate tools and o good corelation of their geometry with the parameters of the gearing process. Except some special cases, the tools are radial relieving (mostly by grinding).
In order to obtain the good localization of the contact path , and to allow the necessary resharpening, the reference diameter of hob is greater than that of the worm gear. Thus the cutting edges of the worm hob will be located on an virtual enveloping surfaces preservering the helical parameter of the worm, but having a reference radius increased with 3...5%. Of curse after resharpening. Both the reference diameter and the cutting egdges profile are modified (fig.12).

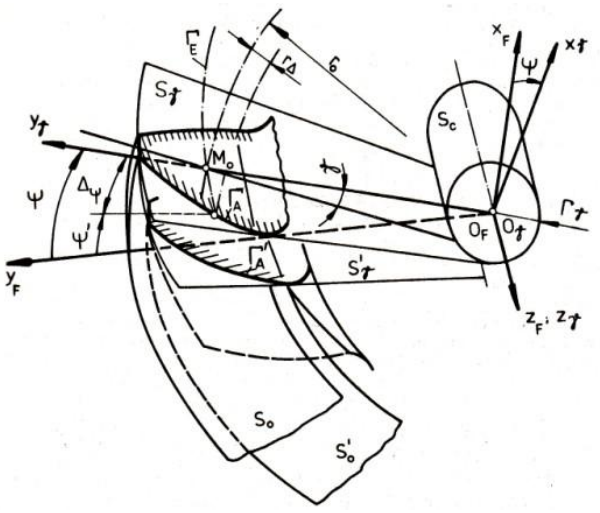

Figure 12.Modification of the cutting edge as a conseqvence of resharpening

The problem of optimization consist in finding a method ensuring a minimum modification of the tool profile after resharpening and consequently a uniform precision of the manufactured worm wheels.
In order to determin the tool profile for radial relieving of hobbing cutter I considered the hob and the relieving tool in an intermediary position (Fig.13).

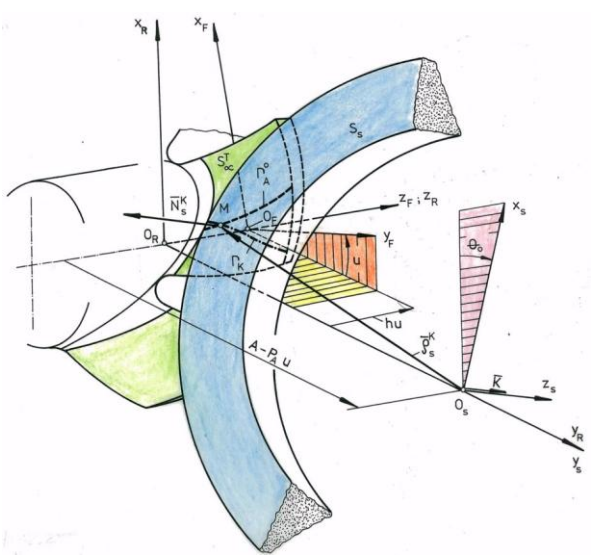

Figure.13 Determination of radial relieving tool profile

The *theoretical accurate lateral surface* S_L^T is in contact with the S_S active surface of the grinding tool across the *characteristically curve* Γ_K.
In order to determine the axial profile of the grinding tool, we use the middle cutting edge Γ_A^0-

located at the middle of the active portion of the lateral surface .
Based on the general equation of meshing, over the characteristically curve, the normal vector is perpendicular on the relative speed v_{FS}, which mathematically is expressed by the equation :

$$\left(y_\alpha^T - P_A.\sin u\right)n_{\alpha x}^T - \left(x_\alpha^T - P_A.\cos u\right)n_{\alpha y}^T + h.n_{\alpha z}^T = 0 \quad (8)$$

With the parameter, determined by this way, the grinding tool profile for relieving, under a general form, can write:

$$\overline{\rho_S} = M_{SF}.\overline{\rho_\alpha^T} = \overline{\rho_S}(p,\psi), \quad (9)$$

where M_{SF} -is the transfer matrix between coordinates systems $O_S X_S Y_S$ and $O_F X_F Y_F$.
The *real lateral surface* is the surface cinematically enveloped by the grinding tool.
If we over cross the lateral surface of the hob) with the rake face, we obtain the *real cutting edges* Γ_A^R.
The both cutting edges, theoretic and real obtained by these ways, have different positions and shapes, depending on the measure of rescharpening (fig.13).

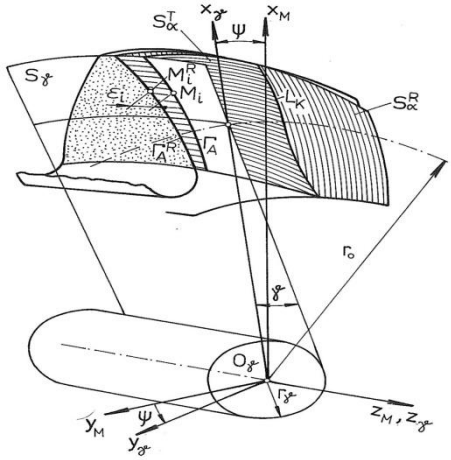

Figure.13. The relative position of the theoretically and real cutting edges

According to the [2] *theoretical errors of hob edges profile* are defined as a difference between the profile of real cutting edges Γ_A^R -and the profile of theoretical cutting edge Γ_A.
The local deviation of the profile is determined with following equation:

$$\varepsilon_i = z_c(p) + h.v - z_{\alpha i}^R = \varepsilon_i(p, p_i). \quad (10)$$

The *cumulated deviation* is given by the relation:

$$\Phi = MAX\left[\varepsilon_i\right] - MIN\left[\varepsilon_j\right], \quad (11)$$

In the *process of worm hob precision optimization* the object function is the cumulated deviation defined by relation (16). On purpose analyzing the variation of function with respect of resharpening parameter ψ, as well as side relief angle α_l, it was tested in a real case. Figure 14 shows the convex form of function as well as the linear dependence.
From the previous researches [2] it is known that the function Φ, also depends on rake angle γ (fig.15).

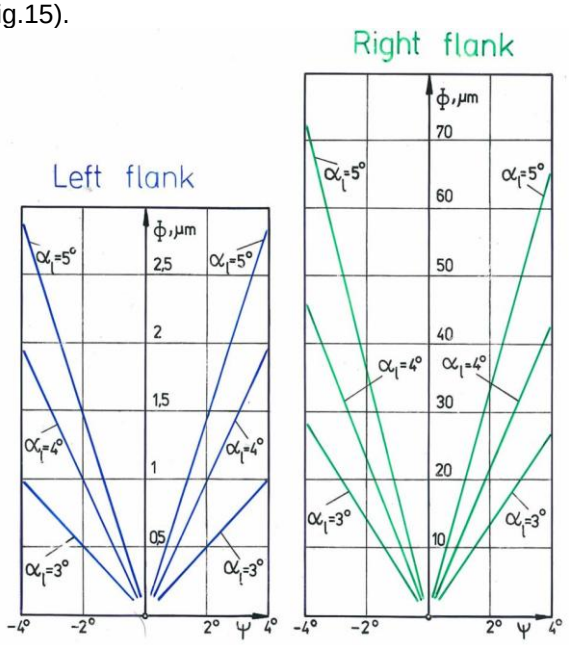

Figure 14. Variation of Φ function for $\gamma = 0$.

One sees that for every stage of resharpening there is an optimum value for which the function Φ is minimum.

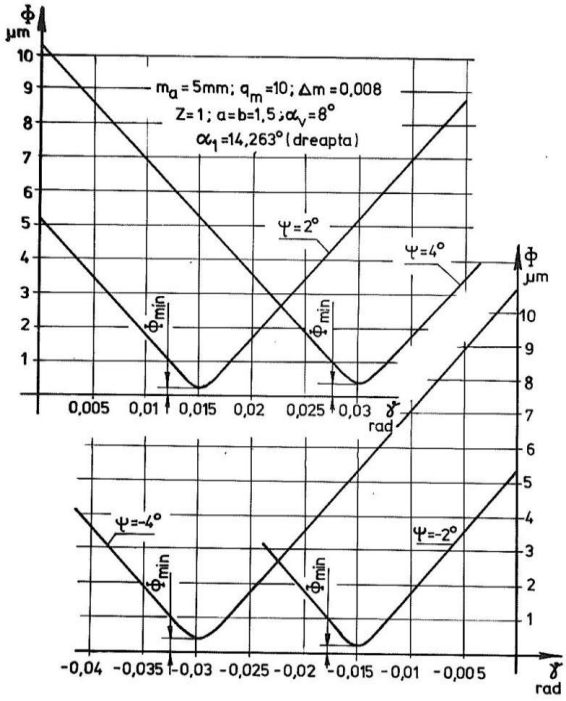

Figure.15. Variation of Φ function for relative with resharpening parameter ψ , and rake angle γ.

For optimization the hob geometry according to variations of function *T* I considered a number of cutting edges defined by *n* discrete points. Based on figure 13 for each of $\Psi(\gamma)$ curve, we can find a parabola given by following formula:

$$\Phi = \Phi(\gamma, \psi) \qquad (12)$$

The local error can be calculated with following equation:

$$\delta_q = B_1.\gamma_q^2 + B_2.\gamma_q + B_3 - \Phi_q \qquad (13)$$

The square average error is defined by :

$$\Delta = \frac{1}{Q}\sum_{q=1}^{Q}(\delta_q)^2 = \frac{1}{Q}\sum_{q=1}^{Q}(B_1.\gamma_q^2 + B_2.\gamma_q + B_3 - \Phi_q)^2 \qquad (14)$$

Theoretical and technological research results have been tested numerically for different types of precision worm gears manufactured at enterprise UMCugir (Romania).
On further, I present, for example, the results obtained in the case of a worm gear type ZA duplex with the following definition parameters:

$m_a = 5mm; q = 10; \Delta m = 0{,}008mm,$
$z = 2; a = b = 1{,}5; \alpha_v 8^0; \alpha_1 = 14{,}263^0; \alpha_2 = 10^0; \alpha_l = 4^0.$

Theoretical and real axial profiles of the new tool, and the tool after resharpening with $\psi = -4^0$, are shown in Figure16.

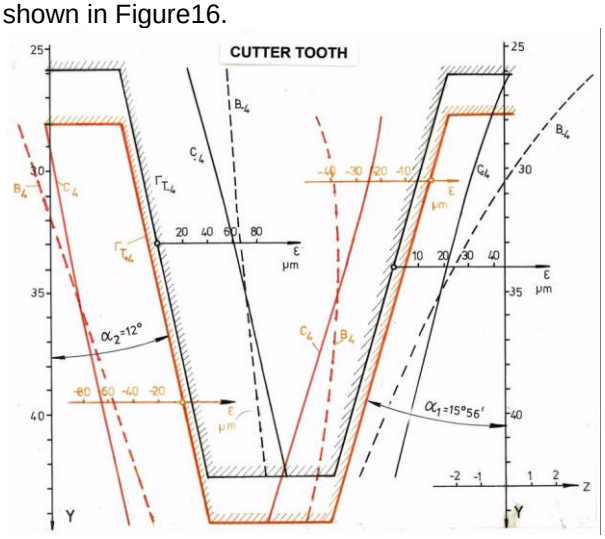

Figure.16.The axial profiles of the new and resharpened duplex hob developed

Analyzing the profiles from figure 10, one can see the followings:
- the profile deviation of the left flank (α_2), in all cases are very small and the real profile of this flank remain approximately parallel to the theoretical profile, in any stage of resharpening;
- on the right flank , the axial profile of unoptimized hob (curves B_{+4}) is convex and concave after the last resharpening;
- the profile deviation of right flank of the unoptim ized cutting tool have over fulfilled the width of tolerance range of AA precision clas (DIN 3968).

Using the two methods for establishing the profile error, we have realized a hob with alternative cutting (fig.17), which has been used for manufacturing the precision worm wheels of the indexing system of gear milling machine-tool.
The manufacturing of wheels has been performed on a PHAUTER P900S machine. The control of realized worm gears have been made using the equipment Dr.Höfler (fig.18).

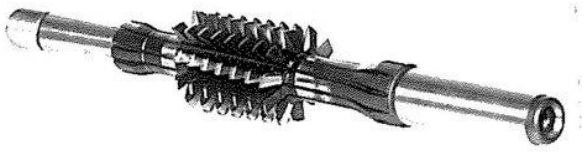

Figure.17. General view of the new duplex hob developed

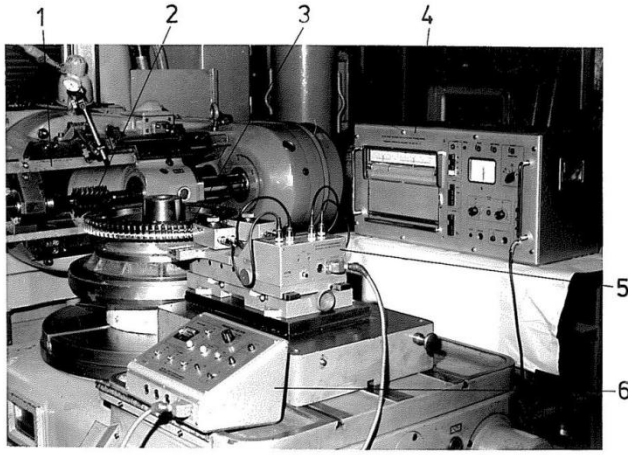

Figure 18. The worm hob and measurement device Dr.HŐFLER installed on a PHAUTER 900S machine tool.

6. CNC gear grinding

For grinding various profile modifications spur gears from different transmissions, we modernized one NILES type grinding machine with FANUC numerical control equipment (Figure 19).

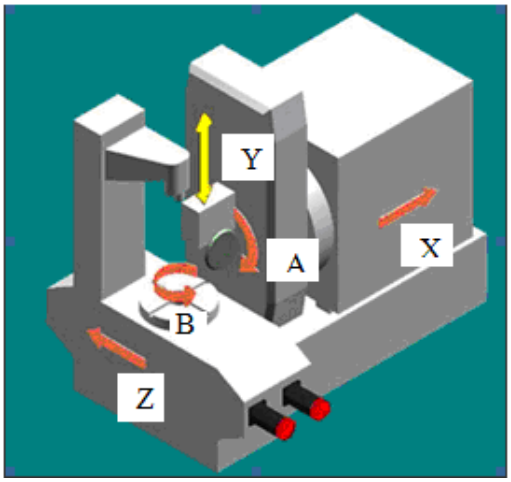

Figure 19. The orientation of the coordinate axes of the CNC gear grinding machine

Movement of gear over flanks of reference rack materialized by the grinding wheel is made of Z and B axes. The X-axis is also controlled by the machine's CNC system, ensuring radial positioning of the tool. For CNC generating of this teeth profile we used the variable speed meshing method. Thus the pitch line is made up from three portions and the generating process are achieving at bases circles R_{bf}, R_b, R_{ba} (figure 20).

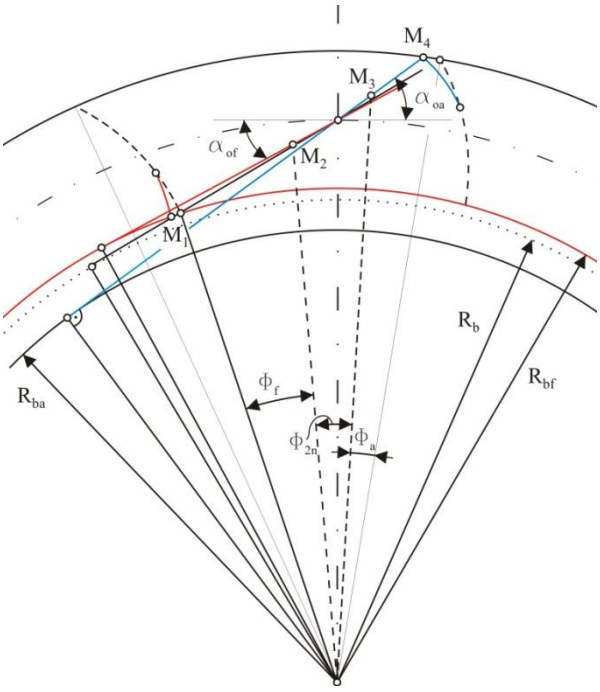

Figure 20. Generating the tooth's flank with three involute parts

Thus, for calculating the programming parameters needed for grinding the three portions of the flank (respectively to cover the pitch line), were developed the necessary algorithms, for gears defined on different norms (STAS, DIN, AGMA, etc).

The measurements made on GHIBLI TRAX - CNC apparatus, show that the different parameters of gears manufactured with developed CNC method are appropriate at precision class 5-after DIN 3962. After our modest opinion it is one good result.

7. Environment friendly cutting of cylindrical gears

In order to evaluate the effects of some environment friendly techniques. we made some theoretical and practical researches in the field of cylindrical gear milling using several kinds tools, lubrication and cooling methods.

The main part of experimental researches has been done on the Gear Milling Machine *Pfauter PE 500 CNC (Figure 21).*

Work piece parameters

- Material: 16 Mn Cr15
- Modulus: 2.75 mm
- Number of teeth: 37
- Diameter: 110 mm
- Teeth breadth: 19 mm

Figure 21. Environmetal lubricant devices on Phauter PE-500 CNC milling machine.

Used tools

- Worm hob from EMo5Co5 with TiN coating

Lubricants

- 0.4 ml / min vegetal oil by MQL
- 100 l / min ROTANOR oil by flood lubrication

We used the following cooling methods:

- Classical Flood (CF) of soluble oil Rotanor with a flow rate of 100 l/min.
- Minimal Quantity Lubrication (MQL) with a mixture of air and vegetable oil (0.4 ml/min) pulverized in airflow by 5 bar of pressure using a device with 2 nozzles.
- Minimal Quantity Cooling (MC) with emulsion (15ml/min) in airflow by 5 bar.
- Minimal Lubrication and Cooling (MQL+MC) – a combination between minimal lubrication and minimal cooling.
- Dry Cutting (DC) (without fluid).

The conclusions of our researches in this field was that MQL represents itself as a viable alternative for gear milling with respect to tool wear, heat dissipation, and machined surface quality.

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THE MICRO-GEOMETRIC MODEL OF THE TOOTHFLANKS OF A CYLINDRICAL GEAR WITH ARCHIMEDEAN SPIRAL SHAPED TOOTHLINE

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Abstract
The present paper discusses a peculiar aspect of the real meshing phenomenon that appears by cutting of a special type of cylindrical gear having curved teeth. Here the flank line is derived from an Archimedean spiral. Using this tooth line-shape the load capacity of the gear pair will be significantly increased while the torque transmission is realized contacting a concave and a convex surface. The phenomenon of the meshing involves a special generating rack that simultaneously executes a pulsing motion and a slow tangential feed. The real meshing phenomenon is realized by the partial surfaces that appear as trails of the cutting edges during relative motion of the edge reported to the cut gear. The paper shows the mathematical model and the density, the displacement and the shape variation of these surfaces during the cutting cycle.

Keywords:
Gear, meshing, generating surface, geometry, curved tooth

1. Introduction

Cylindrical gear transmission is the most frequently used in the machine industry (about 95%). Despite of their very wide application range two types were widespread applied: the right teethed and the helical teethed cylindrical gear pair. The load capacity and the performance of the transmission can be set at desired parameters by optimizing the profile correction and addendum modification values as well as by localizing the contact patch. However, external gears contacts on convex tooth flanks. It is proved that load capacity can be improved if the torque is transmitted between a concave and a convex surface. One solution is given by the Wildhaber-Novikov gear pair, where a concave and a convex tooth surface contacts when torque is transmitted. This type of gear has proved its advantage regarding the load capacity but presents also disadvantages because its sensibility to the axis distance variation. However, this type of gear were widely studied and optimized [1, 2] but its production costs still remain high.

External cylindrical gear pair with curved teeth denotes a solution where concave and convex tooth surfaces contact in order to increase the load capacity, but the manufacturing costs including the costs of the tooling and the technological system setting remain at classical gear manufacturing costs level.
The principle of generating is deduced from Olivier's first principle [3]. The coupling toothflanks are theoretically generated by the same generating surface. The principle of generating is shown on figure 1.

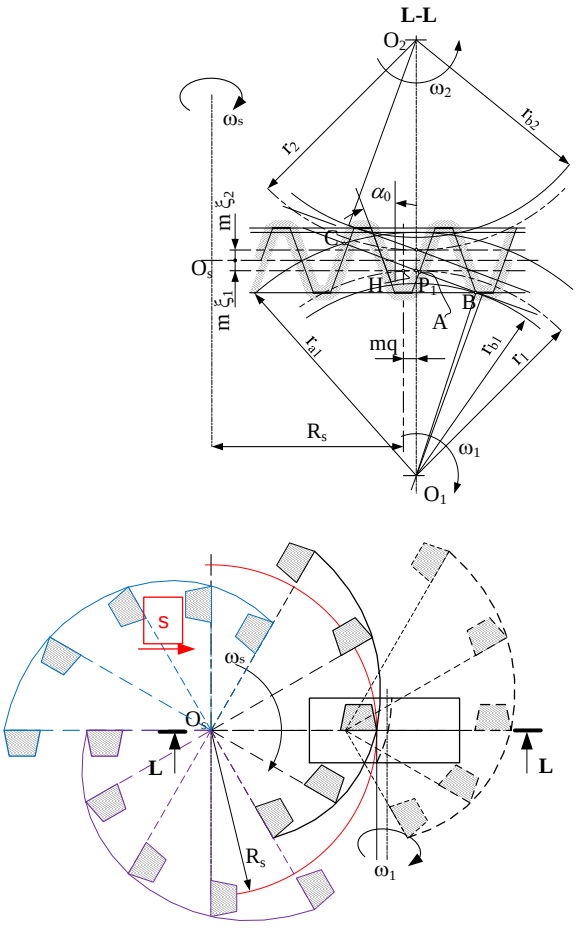

Figure 1. The principle of generating

The theoretical generating surfaces are the carrying surfaces of the cutting edges. Each cutter's profile is identical with the profile of the involute gear generating rack. The profiles are disposed in radial planes and guided on an Archimedean spiral. In the lower image of figure 1 the sketch of the milling head is presented. It presents 3 groups of 5 cutters for each. The cutters are disposed on identical Archimedean spirals. When the milling head rotates, a moving rack appears that cuts the teeth of the workpiece whose axis of rotation passes through O_1. Details regarding the mathematics of the surface meshing process are given in [4, 5]. Focusing on figure 1 it is to observe that the milling head realizes $Z_0 = 3$ Archimedean generating surface-systems each one materializing a tooth of a rack with curved teeth. Each one group of cutters operate in different tooth spaces realizing the convex (left sided) and the concave (right sided) toothflank. For one rotation of the milling head the manufactured gear rotates with an angle comprising Z_0 angular pitches. This relative motion involves a coupling between a theoretical rack segment and the cut gear. The superposition of the tangential feed on the main cutting motion leads to the model of the pulsing rack. Pulsing motion is a high velocity speed of the rack till it cuts in the space. When the analyzed space turns again in the working position the pulsing rack is moved in another position, finally the whole space will be generated.

2. The geometric model

Theoretical enveloping of the toothflanks can be computed using a generalization of the classical models and methods [1, 6]. In the reality, the meshed toothflank is the union of the surfaces described by the cutting edges during the relative motion. In the practice of gear generating there exist realistic studies that emphasize the real aspect of the cut surface [7]. However a mathematical model that predicts the possible arrangement of the surface patches is necessary.
Here the shape of the surface is determined by the position of the cutting edge in the group and by the position of the milling head meaning the axis distance between this and the axis of the machined gear. The simplified model of the relative position uses only the specific coordinate-frames attached to the elements of the technological gear (Figure 2).
The following frames are used:
The $X_0Y_0Y_0$ fixed frame;
The $x_sy_sz_s$ milling head attached frame;
The $x_1y_1z_1$ machined gear's frame.
The reference position of the frames in indicated with superior zero indices: $x_i^{(0)}y_i^{(0)}z_i^{(0)}$, $i \in \{s;1\}$. The (x_iz_i) planes are included in the median section of the cut gear whose width is denoted with B. P is the pole of the virtual gear pair consisting of the theoretical rack and the machined gear.

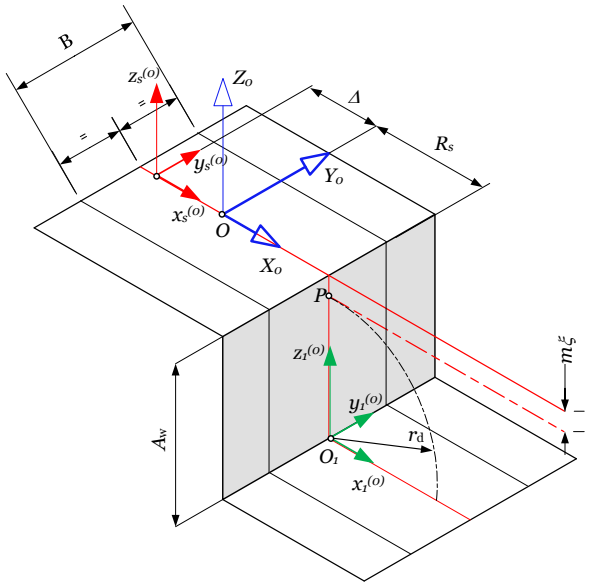

Figure 2. The used coordinate frames

One group of cutter contains a number of $z_s = 5$ cutters. The central one is considered the referential cutter. Its symmetry point (middlepoint of the toothwidth segment on the rack's pitch line) is positioned at a distance R_s from the milling head's axis. It is denoted through index $I = 0$. As a logical consequence the set of the indices is $I = \{-2;-1;0;1;2\}$. The first insert with index value $I = -2$ has the shortest radius, and the last the longest. The pitch of the Archimedean spiral is due to the gearing dependences Z_0 times the standard rack pitch. The parameter of the spiral line becomes

$$p_{sp} = Z_0 \pi m / (2\pi) = m Z_0 / 2 \qquad (1)$$

Considering that $\tau_s = 2\pi / Z_0$ is the theoretical central angle occupied by the cutter group and the axis x_s is set on the reference cutter, the minimal and the maximal radius become:

$$\rho_{\min}^{\max} = R_s \pm \frac{\tau_s}{2} p_{sp} = R_s \pm \frac{\pi m}{2} \qquad (2)$$

The angular pitch between two consequent cutters of the group is:

$$\delta_\lambda = \frac{\tau_s}{N-1} \qquad (3)$$

Using the index value the angular distance of an arbitrary cutter to the first cutter of the group is:

$$\Delta\lambda_I = (2+I)\delta_\lambda \tag{4}$$

Using (2) and (4) the reference radius of all cutters can be written as

$$\rho_0^{(I)} = R_s - \frac{mZ_0}{2}\Delta_{\lambda I} \tag{5}$$

The analysis of the micro-geometry requires a precise relative positioning of the generating surfaces swept by the edges. Generating surfaces are considered only within the limit planes of the cut gear. Starting position of the frames is always considered that position of the cut gear and the milling head where the reference point *A* of the first cutter (index -2) reaches the gear limit plane of equation $Y_s = B/2$ as shown in figure 3. This is valid for any Δ distance of the milling head's axis that indicates the position of the rack during the cutting process (figure 1).

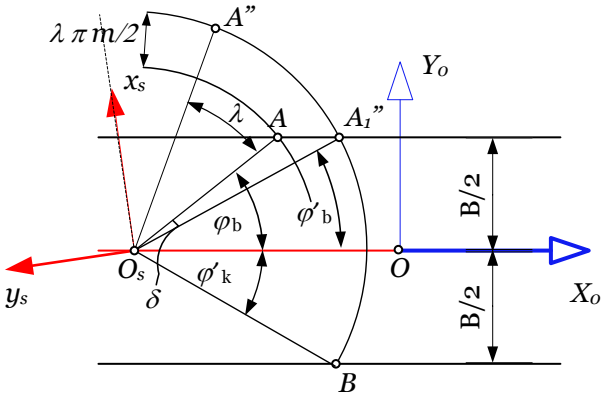

Figure 3. The angular distance and the coverage angle of an arbitrary edge

Coverage angle is the value of the angular motion of the milling head till the analyzed cutter's edge passes through the width of the machined gear. For example, first edge's coverage angle is $2\varphi_b$. Reference point *A"* of the arbitrary edge reaches the limit plane in *A1"*. The coverage angle value is $2\varphi_b'$. The beginning of the arbitrary edge swept surface happens after a rotation of the milling head of value $\delta + \lambda$ where

$$\delta = \arcsin\frac{B}{2\rho_{\min}} - \arcsin\frac{B}{2\rho_{\min} + \lambda m Z_0} \tag{6}$$

While the milling head rotates it also execute the tangential feed. Here an analogy with the gear shaping technology is needed. It can be accepted that the length of the milling head's shift while the gear executes one complete rotation is equal to the circular feed *s*. The feed ratio will here be defined as the length of the shift that corresponds to a rotation of 1 radian:

$$s^* = \frac{s}{2\pi}\frac{Z_0}{z_1} \tag{7}$$

The gearing ratio is computed considering a perfect rolling between the centroids of the rack and the gear. Equalizing the tangential velocities it can be written that

$$v_t = \omega_1 r_d = \omega_s p_{sp} + s^*\omega_s \Rightarrow i_{1s} = \frac{\omega_1}{\omega_s} = \frac{p_{sp} + s^*}{r_d} \tag{8}$$

The limit positions of the milling head during the cutting of a tooth space is approximated with the model of rack-involute gear pair as shown in figure 4.

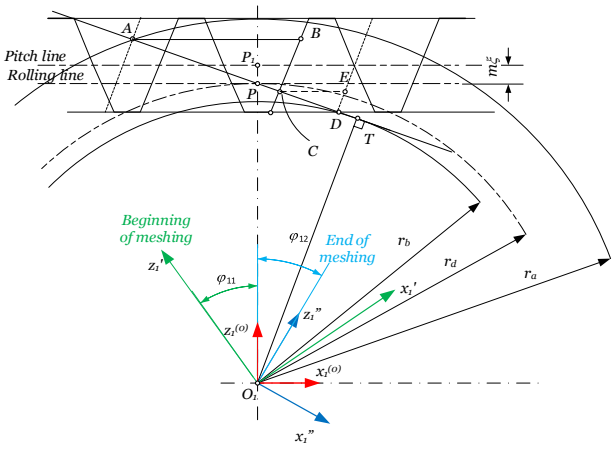

Figure 4. The limit positions of the meshing

Using figure 4 the φ_{11} and φ_{12} values can be easily computed. The complete length of the feed shift is given by

$$\Delta_\Sigma = r_d(\varphi_{11} + \varphi_{12}) \tag{9}$$

Finally the geometrical dependence of the moving frames must be determined. Let's consider the frames shown in Figure 5.

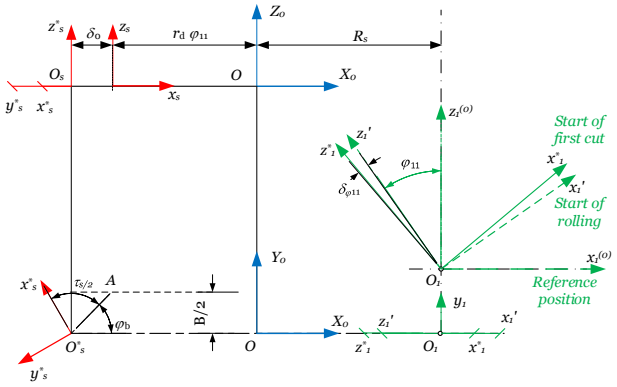

Figure 5. The relative positions of the frames when first cutter starts.

Comparing the frames shown in figure 2 with those shown in figure 5 it can be concluded that the mill's frame must be rotated counterclockwise by an

angle $\zeta_s = \tau_s / 2 + \varphi_b$ while point A of the first cutter reaches the gear;s limit plane. Due to the rolling it must be also shifted with the distance $\delta_0 = s^* \zeta_s$. Frame of cut gear is also rotated ccw. by $\delta_{\varphi 11} = i_{1s} \zeta_s$. If another cutter is considered than the milling head must be rotated clockwise with a supplementary setting angle computed from (4) and (6):

$$\psi_{si} = \Delta_{\lambda i} + \arcsin\frac{B}{2\rho_{\min}} - \arcsin\frac{B}{2\rho_{\min} + \Delta_{\lambda i} m Z_0} \tag{10}$$

Supplementary rotation is needed to correct the gear's position too, reaching $\psi_{1i} = i_{1s}\psi_{si}$. These are the start angular values when the cutters work at the beginning of the rolling segment. After *n* revolutions of the cut gear the mill's axis is shifted right with a distance $\delta_s = 2\pi n s^*$. In order to avoid the senseless complication of the model let's consider δ_s a continuous variable. For this position of the mill's axis the cut gear must be rotated clockwise with $\theta = \delta_s / r_d$. Based on the statements above the angular positions of the frames for an arbitrary cutter and an arbitrary rolling position can be computed as follows:

$$\begin{cases} \angle(x_s, x_0) = \tau_s / 2 + \varphi_b - \psi_{si} \\ \angle(x_1, x_1^{(0)}) = \varphi_{11} + \delta_{\varphi 11} - i_{is}\psi_{si} - \delta_s / r_d \end{cases} \tag{11}$$

For an arbitrary position of the cutting edge during the sweeping of the generating surface, considering principal parameter the rotation φ_s of the milling head the expressions (11) become the general form

$$\begin{cases} \angle(x_s, x_0) \to \sigma_s = \tau_s / 2 + \varphi_b - \psi_{si} - \varphi_s \\ \angle(x_1, x_1^{(0)}) \to \sigma_1 = \varphi_{11} + \delta_{\varphi 11} - i_{is}\psi_{si} - \delta_s / r_d - i_{1s}\varphi_s \end{cases} \tag{12}$$

The transformation matrix between the mill's and the cut gear's frame is:

$$\mathbf{M}_{1s} = \begin{pmatrix} \cos\sigma_1 \cos\sigma_s & -\cos\sigma_1 \sin\sigma_s & \sin\sigma_1 & x_0^{(s)}\cos\sigma_s + x_1^{(0)} \\ \sin\sigma_s & \cos\sigma_s & 0 & 0 \\ -\sin\sigma_1 \cos\sigma_s & \sin\sigma_1 \sin\sigma_s & \cos\sigma_1 & -x_0^{(s)}\sin\sigma_s + z_1^{(0)} \\ 0 & 0 & 0 & 1 \end{pmatrix} \tag{13}$$

where constants of the fourth column are computed as follows:

$$\begin{aligned} x_0^{(s)} &= -(r_d\,\varphi_{11} + \delta_0) + s^*\,\varphi_s + \delta_s \\ x_1^{(0)} &= -R_s \cos\sigma_1 + A\sin\sigma_1 \\ z_1^{(0)} &= R_s \sin\sigma_1 + A\cos\sigma_1 \end{aligned} \tag{14}$$

3. The equations of the cutting edges

The equations of the cutting edges relative to the frame of the milling head are computed using figure 6. The equations are written first in the auxiliary frame $x_2 y_2 z_2$, followed by a rotation. The concave and the convex sided edges can be

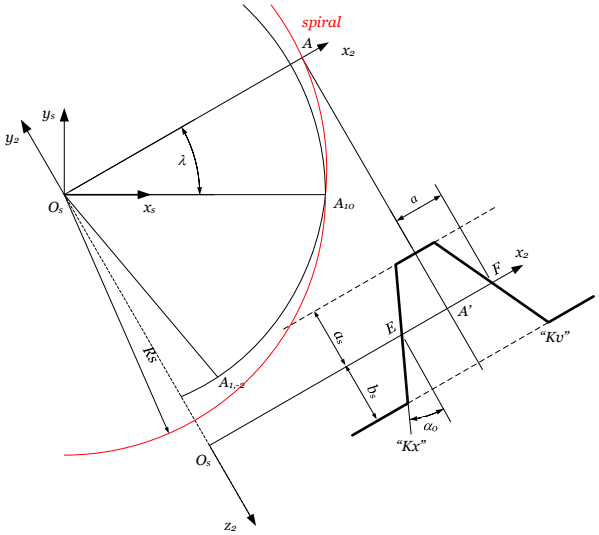

Figure 6. The cutting edges in the frame of the milling head.

written using a single equation system.

$$T_{Kv,Kx}: \begin{cases} x_s(u;\lambda) = \left[\nu(a + u\,\mathrm{tg}\alpha_0) + R_s + \lambda\, p_{sp}\right]\cos\lambda \\ y_2(u;\lambda) = \left[\nu(a + u\,\mathrm{tg}\alpha_0) + R_s + \lambda\, p_{sp}\right]\sin\lambda \\ z_2(u) = u \end{cases} \tag{15}$$

The concave flank's parametric equations will be obtained for $\nu = +1$, as appropriate the convex flank results for $\nu = -1$.

4. The equations of the swept surfaces

Using the elements of the model presented above, the surfaces swept by the edges can considered as the simple infinity of edges in the frame of the cut gear determined by the values of parameter φ_s. The equations are written using matrix (13) and equations (15) within the matrix transformation

$$\underline{\mathbf{r}}_1 = \mathbf{M}_{1s}\ \underline{\mathbf{r}}_s \tag{16}$$

5. Computer simulation results

The simulation was realized in MathCad 15 environment, for the following initial values:
module $m = 5$ mm;
rack profile angle $\alpha_0 = 20°$;
teeth number $z_1 = 41$;
profile correction $\xi = +0.15$;
gear width $B = 40$ mm;
spiral reference radius $R_s = 80$ mm;

number of cutter groups $Z_0 = 3$;

number of cutters in the group $z_s = 5$;

circular feed $s = 0.3$ mm/rev.workpiece.

The length of the rolling segment is 40.702 mm on which a 9 segment equidistant division was considered. This marks 10 equidistant points including the ends of the rolling length. Each point present a possible position of the milling head's axis when the generating process begins with the first edge. The program computes the coordinates depending on the cutter's index value and the milling head position.

Two types of representations were done. The first type shows the succession of the surfaces generated successively by each cutter of the group. The second representation tries to answer the successive positions of the surfaces swept by the same cutter, during the linear motion of the milling head due to the tangential feed.

First type of representation is shown in figures 7-12. Figures 7, 9 and 11 contain the surfaces swept by the edges from the concave side, while figures 8, 10 and 11 those that appear on the convex side.

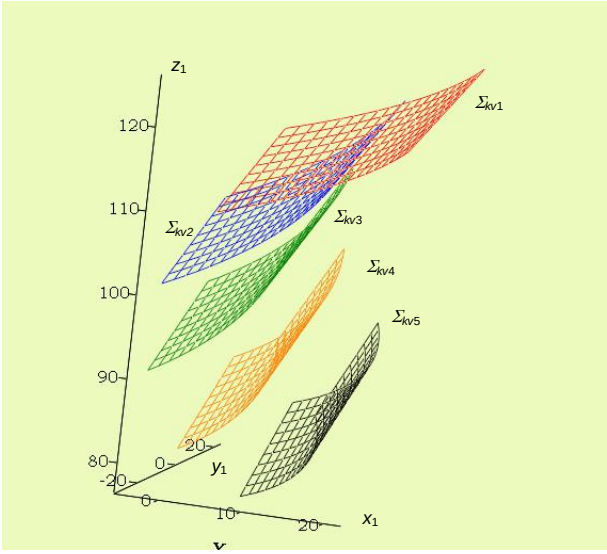

Figure 7. The swept surfaces on the concave side at the beginning of the rolling distance.

On any of the figures $\Sigma_{kvi}, i \in \overline{1..5}$ denotes the concave surface swept by the edge of the cutter i, where $i = 1$ marks the first cutter of the group. In analogy $\Sigma_{kxi}, i \in \overline{1..5}$ is the notation for the convex side.

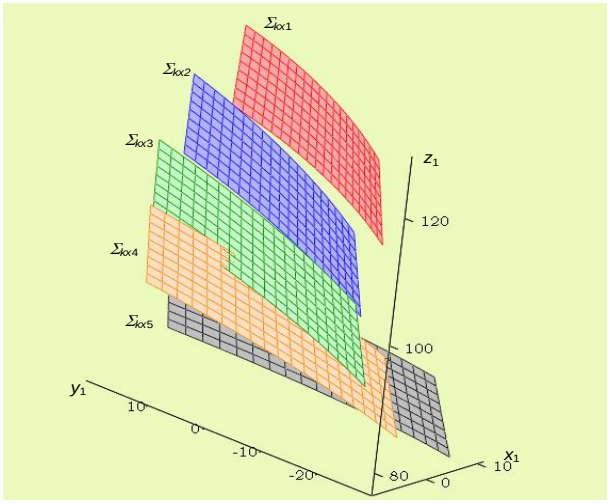

Figure 8. The swept surfaces on the convex side at the beginning of the rolling distance.

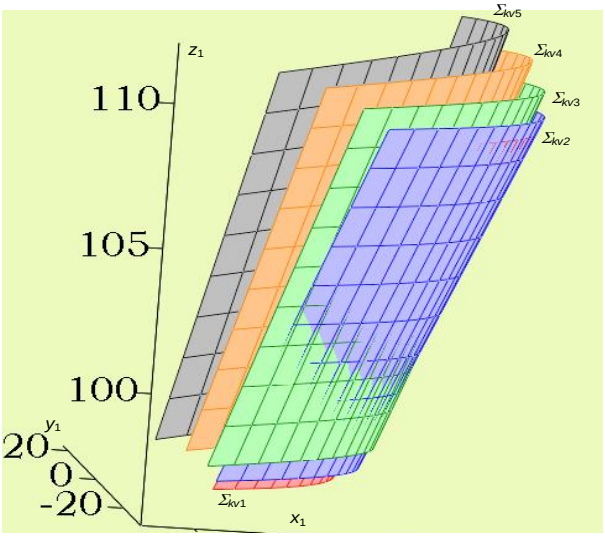

Figure 9. The swept surfaces on the concave side at the middle of the rolling distance.

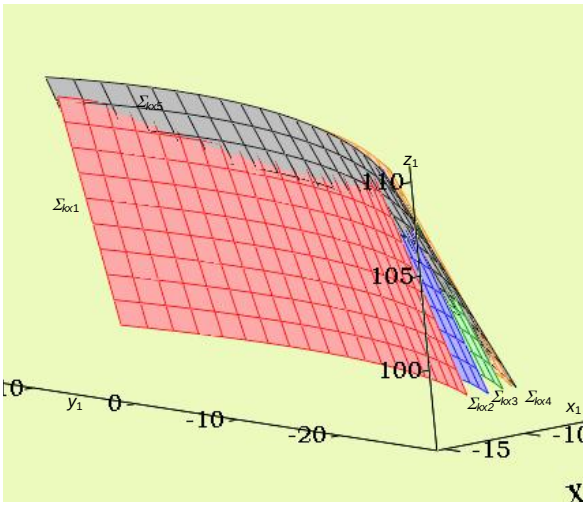

Figure 10. The swept surfaces of the convex side at the middle of the rolling distance

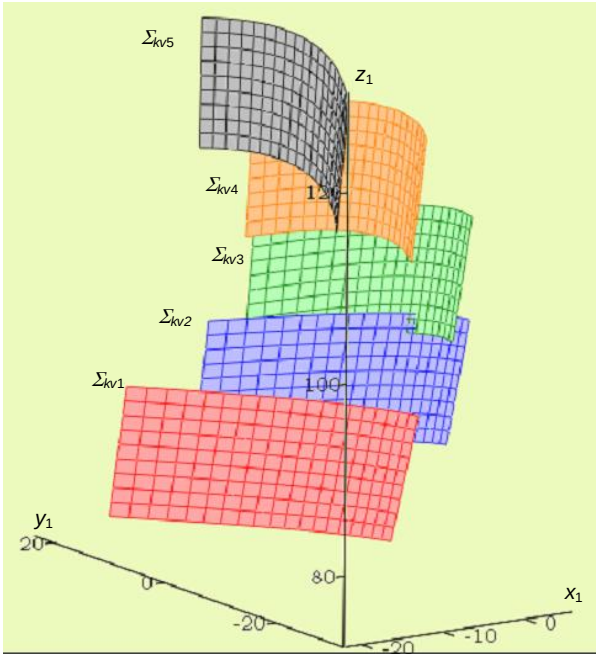

Figure 11. The swept surfaces of the concave side at the end of the rolling distance

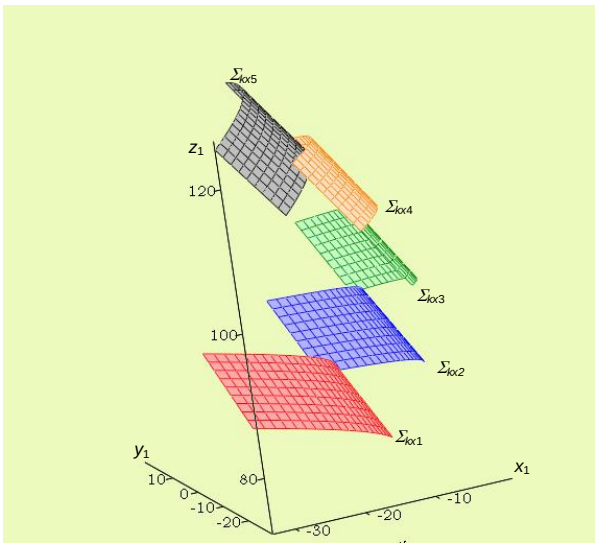

Figure 12. The swept surfaces of the convex side at the end of the rolling distance

Analyzing figures 7-12 it is to conclude that the considered surfaces present a very various arrangement depending on the position of the milling head's axis during the rolling. Near the ends of the rolling segment the surfaces are distanced, but in the middle zone of the rolling segment the distance between them becomes significantly small. Generally it can be admitted that surfaces swept by two consequent edges doesn't intersect. It is not possible to write an approximant for the meshing surface using the intersection curves between the consequent swept surfaces. In some situations it exist the intersection between two consequent surfaces but this cannot be considered as a certainty.

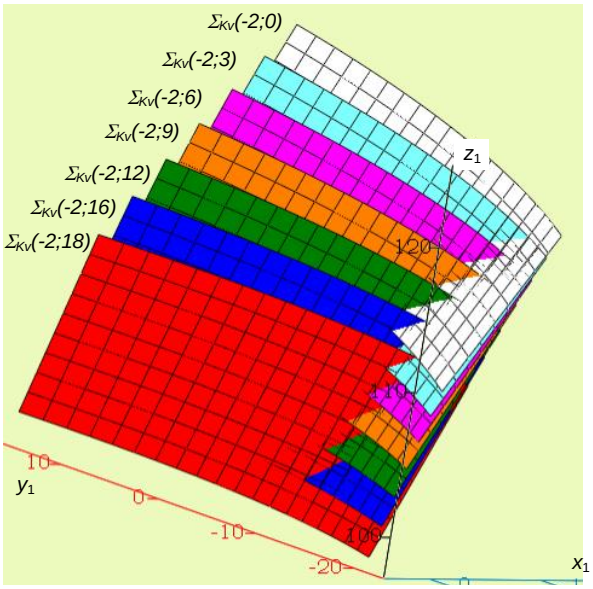

Figure 13. The successive surfaces swept by the concave edge of the first cutter of the group for different rolling positions

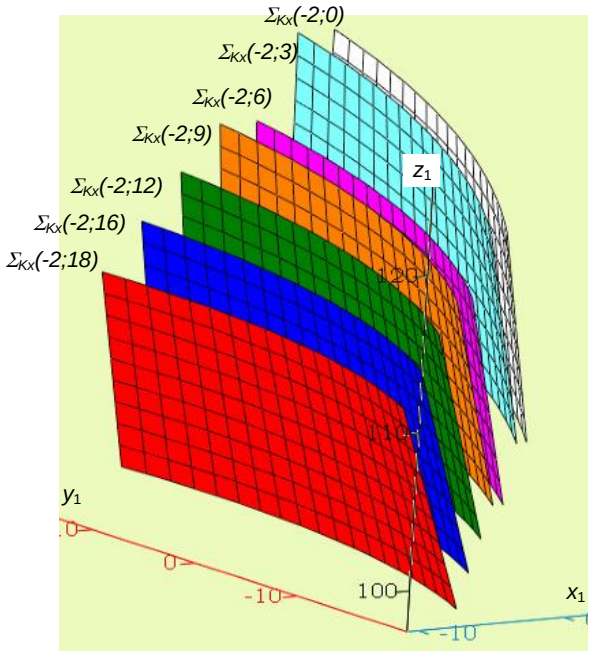

Figure 14. The successive surfaces swept by the convex edge of the first cutter of the group for different rolling positions

A similar arrangement of the surfaces can be observed when analyzing the second representation. The step was set on 3 mm, corresponding to 10 complete rotations of the workpiece. The results of the computing are presented in figures 13-18. The annotations for the surfaces are similar to the precedent, but they are completed with a parenthesis, where first number signify the index of the cutter that was used in the formulas above, and the second the distance covered by the milling head due to the tangential

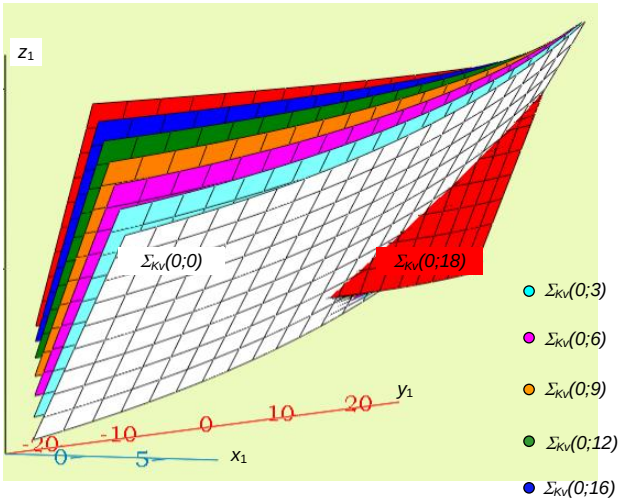

Figure 15. The successive surfaces swept by the concave edge of the central cutter of the group for different rolling positions

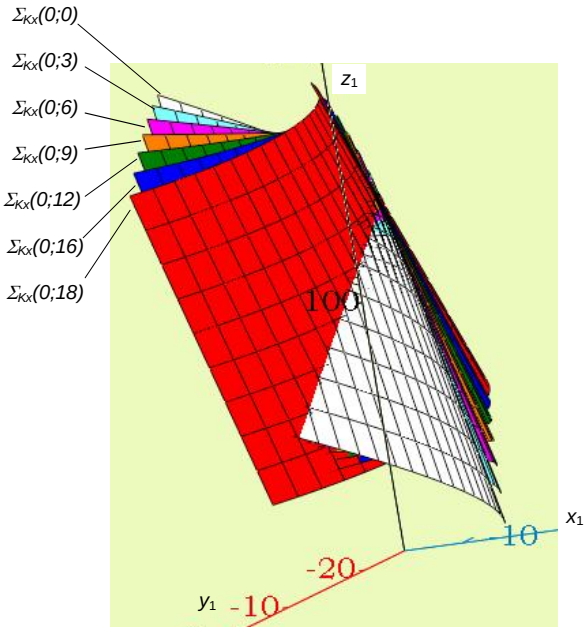

Figure 16. The successive surfaces swept by the convex edge of the central cutter of the group for different rolling positions

feed. For example, $\Sigma_{kv}(-2,12)$ signify the surface swept by the concave (here: the right sided) edge of the first cutter in the group ($I=-2$).

It is to conclude that the arrangement of the surfaces depends on the position of the cutter in the group, and differs from the concave to the convex side. Analyzing figure 13 it is to concludeThat surfaces swept by the concave edge of the first cutter in the group are quasi linear disposed considering any intersections at the exit side, when edges leave the space of the cut gear. But the convex edge of the same cutter produces more distanced surfaces. Comparing figures 15 and 16 a similarity appear regarding the arrangement, while surfaces are interlocked.

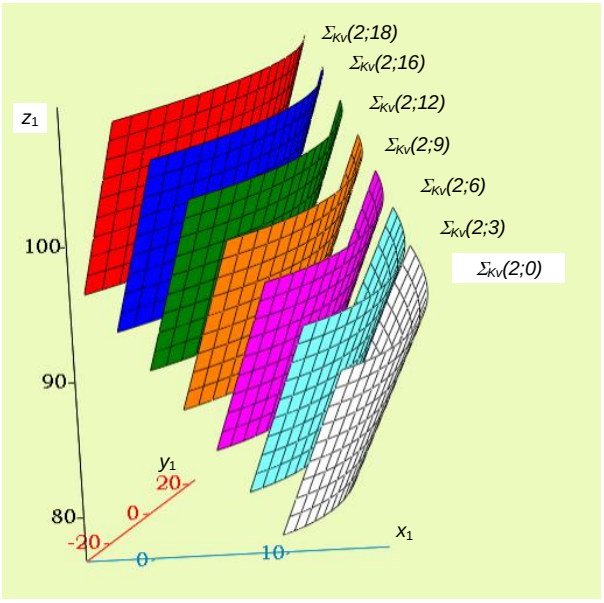

Figure 17. The successive surfaces swept by the concave edge of the last cutter of the group for different rolling positions

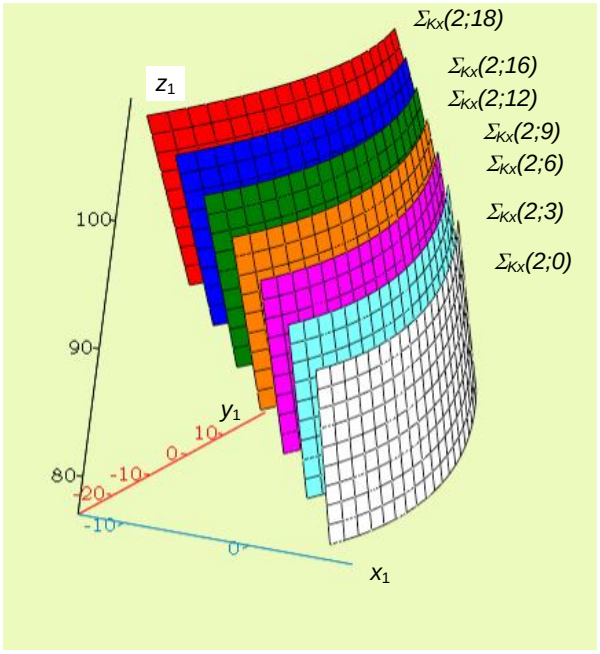

Figure 18. The successive surfaces swept by the convex edge of the last cutter of the group for different rolling positions

Finally, comparing figures 17 and 18 it can be noticed that last cutter's edges produce similar arrangement as shown in figures 13 and 14. In opposition to those, here surfaces swept by the convex side are closer arranged that at the concave side.

6. Conclusion

Computer simulation results demonstrates that the enveloping surfaces manifold is more complex in comparison with classical situations (gear shaping with rack, with cutter, gear hobbing).

Due to the two component based kinematic of the cutting tool (first the pulsing rack simulated by the cutter group and the second the tangential motion of the milling head) the virtual rack thast realizes finally the meshing changes its dimensions, the form and the curvature of the generating surface. As a consequence situations of ante and posterior undercut can appear. For example, let's consider that a curve segment situated on the holder surfaces of the cutting edges (this is an Archimedean surface, [4]) fulfills the law of gearing [1, 3, 6, 7] when the milling head is located in some place of the rolling line. Due to the changing of the relative position of the edge swept surfaces during the tangential feed the meshing segment that was calculated before can be eliminated during the next cutting process. Or, it can be considered a segment of curve that fulfills the low of gearing but it was cut down in a precedent cutting phase.
Despite of this inconvenience the Archimedean spiral curved teeth match the requirements of correct coupling due to the law of Willis and Olivier's first principle regarding the common generating surfaces.
The correct calculus of the tooth flank form requires besides the applying of the law of gearing a numerical checking of the existence of the theoretically computed points. This can be performed through using the surfaces swept by edge as limit surfaces of the tooth space. Here a CAD-program is indispensable.

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ANALYSIS OF WEAR MECHANISM IN CONICAL PICK FOR COAL CUTTING

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Abstract
WC-Co acquires wonderful combination of hardness and strength, hence it is widely used in the field of coal/rock excavation. The abrasive part of tool which continuously undergoes into shock and impact is made by (or joined by) WC-Co. Conical pick is one of the highly productive tools for coal-cutting operation which are used in mining machines like continuous miner, surface miner, road header etc. Since pick gets severe shocks by coal and various environmental conditions, it gets deformed. The present paper deals with a comprehensive study of wear mechanisms in conical pick which was used in continuous miner machine for coal cutting in mine. Conical pick contains WC-Co tip brazed with steel body. The deterioration of conical pick imparts body and tip wear. Both parts have been critically observed by scanning electron microscopy and energy dispersive X- ray point analysis. Deformed parts reveal four types of wear mechanisms: coal/rock cover formation, coal/rock intermixing, cracks on WC grains and plastic deformation.

Keywords:
Conical pick; coal excavation; wear mechanism; SEM; EDAX

1. Introduction

The production rate of mining machineries is mainly dependent on selection of tool and adopted techniques for excavation. Continuous miner is a highly productive machine in which a number of conical picks are fitted on a rotating drum and coal excavation is carried out. Conical pick imparts a WC-Co tip brazed with steel body. The images of conical pick and continuous miner machine are given in figure 1 (a) and (b) respectively.

(a)

(b)

Figure 1. (a) conical pick; (b) continuous miner machine with fitted conical picks (courtesy: joyglobal) [22]

Literatures reveal that conical pick is more advantageous than other shaped tools. During the cutting action of conical pick, it was found that as the depth of cut increases, specific energy decreases [1]. The shape of conical pick remained sharp due to symmetrical wear during cutting [2]. Conical tool provides better efficiency due to lowest specific energy for penetration [3]. The conical pick has longer life than radial bits [4]. The tip of the pick is made by WC-Co. The performance of cemented carbide in terms of hardness, strength, toughness, and advanced chemical stability is excellent, and due to which it is widely used in the field of metal cutting operation, mines excavation, oil drilling and geological exploration etc [5]. Cemented carbide basically consists of two major phases: hard refractory phase WC and soft metal binder phase Co/Ni. The presence of WC grains impart hardness, strength and wear resistance to cemented carbide, whereas binder phase Co/Ni is responsible for the toughness and ductility of such hard metal alloys [6, 7]. Wear of the cutting tools is one of the most important process parameters for evaluating the economy of process and efficiency of the operation [8]. Wear in general could be defined as the undesirable and continuous loss of the material from a solid surface due to the mechanical interactions such as, contact and relative motion between two bodies [9]. The wear and frictional properties of a material are behavioral parameters which are associated with the operational conditions. The damage can be assumed as the combination of continuous wear of WC/Co and crack formation [10]. In the present

paper, wear analysis of deteriorated conical pick with removed tip has been carried out. Sometimes pick having tip is also considered as worn out. A tool sample has been prepared for experiment purpose.

2. Literature review

A number of researchers studied about wear mechanisms of WC-Co based tool with SEM (scanning electron microscopy) and high resolution field emission gun SEM analysis and they found the main types of the damages of cemented carbide buttons as: *Microspalling, Abrasion Wear, Cracks, WC grain pullout, Extrusion of binder metal and Reptile skin* [11-18]. Beste et al. (2001) tested three CC drill buttons with different hardness (HV) and WC grain size (μm). They used to drill three different depths and concluded that there was a difference between the long initial surface cracks and the damage forming the reptile skin. The initial cracks made up straight continuous lines, while the reptile skin was a phenomenon in a lesser scale [19]. As concluded by Olovsjo et al. (2013), the main controlling parameters of wear of cemented carbide were the plastic deformation, cracking and crushing of individual WC grains. Also, mechanisms such as cobalt depletion and rock material penetration might also have influence on the drill button life up to greater extent [20]. Some plastic deformation phenomenon was seen in the diamond cutting tools also. Gupta et al. (2012) performed SEM analysis of worn diamond cutting tool and unused tool to compare the microstructure after cutting the rock. New tool showed properly bonded diamond particles with nickel matrix but the channels or grooves due to combined effect of excessive loading and bit rotation were seen on worn out bit. It was also noticed that, due to the high temperature produced during core drilling, the matrix had plastically deformed [21].

3. Experimental work

The worn out pick has been taken from continuous miner machine which was used for coal cutting. The phenomenon like tip breakage, tip removal and damage of tool body are usually occured deterioration process which can be observed by eyes but for critical investigation of severity of damage, scanning electron microscopy has been used. For sample preparation, the deteriorated part (upper part) of pick has been cut from top portion. This cut sample of tool has been placed on the work piece stand of the SEM instrument. The tool sample preparation is given in figure 2 (a) and (b) respectively. One can see in figure that the conical tip is completely removed out and body is also severely affected.

(a)

(b)

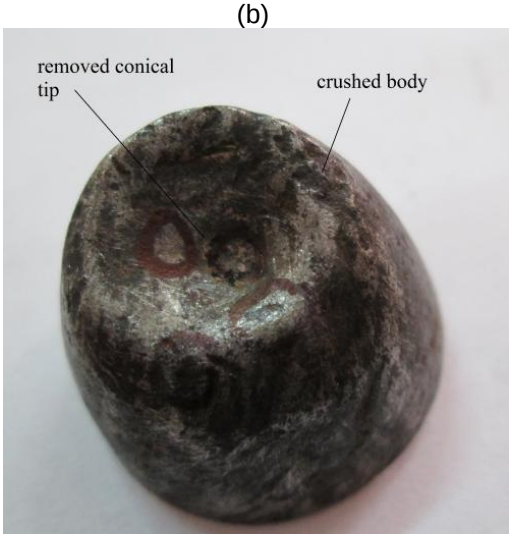


Figure 2. (a) worn out conical pick; (b) deteriorated sample to be examined

4. Deterioration mechanism

Hard rocks are always present in between coal in mine, which are the main cause of tool deterioration. Rock creates high impact on tool during coal cutting operation and produces crack on the tool surface. Sometimes it gets enter into tool material (tip and body) forming binder material between them. The following four types of deterioration mechanisms have been observed by SEM images:

- Coal/rock cover formation
- Coal/rock intermixing
- Cracks on WC grains
- Plastic deformation

Coal/rock cover formation: When tool comes into contact with irregular shaped coal/rock, it gets severe impact from rocks and hence sometimes rock adhered with tool material. It is often to observe a rock/coal cover formation with some

thickness over the tool material. The following figure 3 shows the formation of rock/coal cover over the body material. White arrow indicates the surface of tool and the rock cover is on right side of that.

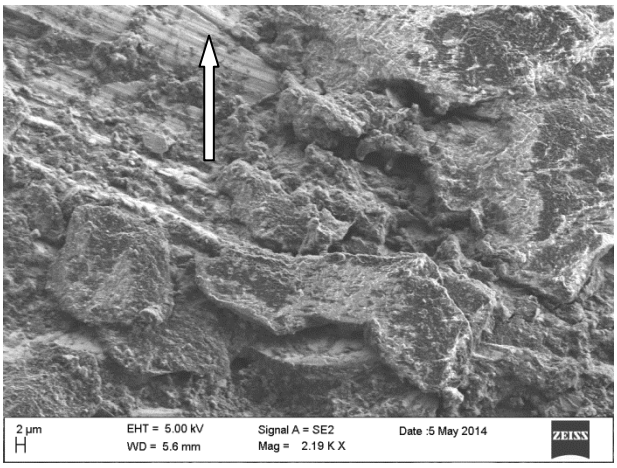


Figure 3. Coal/rock cover formation on tool body

Coal/rock intermixing: Conical pick has been taken from continuous miner machine which was rotated by 54 rpm during coal cutting. Some sharp edges of coal/rock suddenly hit the pick and form cracks on the surface which further facilitate the coal particles to get enter into tool and intermixed with inside material. A completely coal interrupted zone on tool is given in figure 4. Temperature and pressure variation play vital role for this process. Sometimes coal/rock material enters into WC-Co structure and replaces the ductile Co phase and acts as binder phase itself. Usually coal/rock particles mix with binder content and degrade them. Coal intermixed with WC structure is shown by white circle in figure 5.

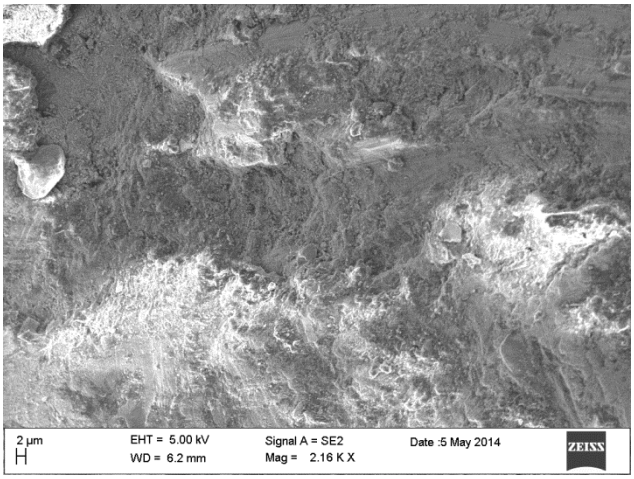


Figure 4. Coal interrupted zone on tool body

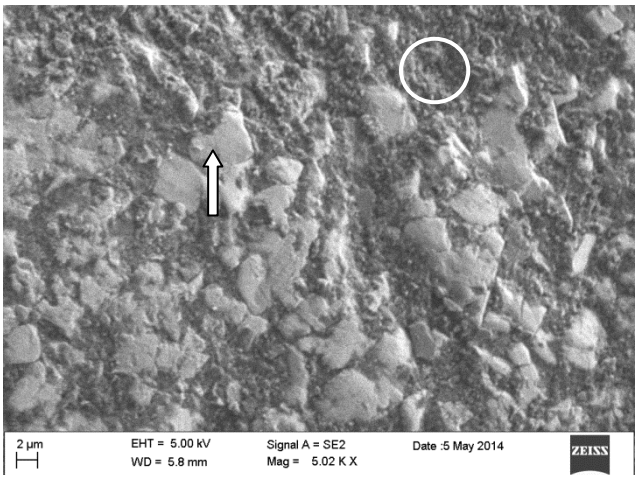


Figure 5. Coal particles (white circle) in between WC structure (white arrow)

Cracks on WC grains: One worn out tool having WC-Co tip has also been examined. Since the drum of continuous miner was rotated continuously to cut the coal, therefore high amount of sudden impacts were imposed on the tip of tool by the intermidiate rock materials which facilitated the generation of cracks on the hard WC grains (figure 6).

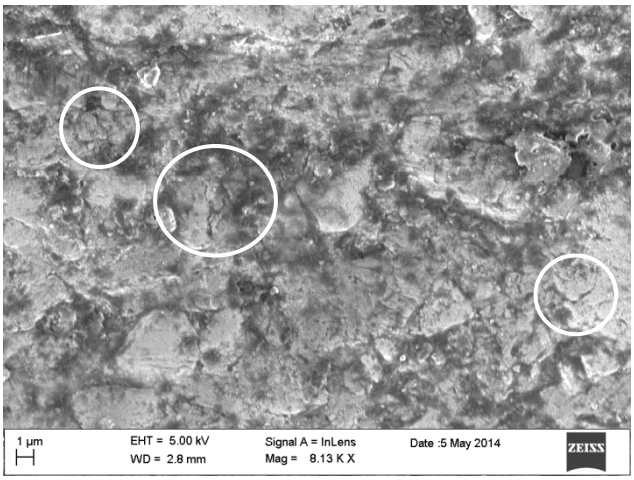
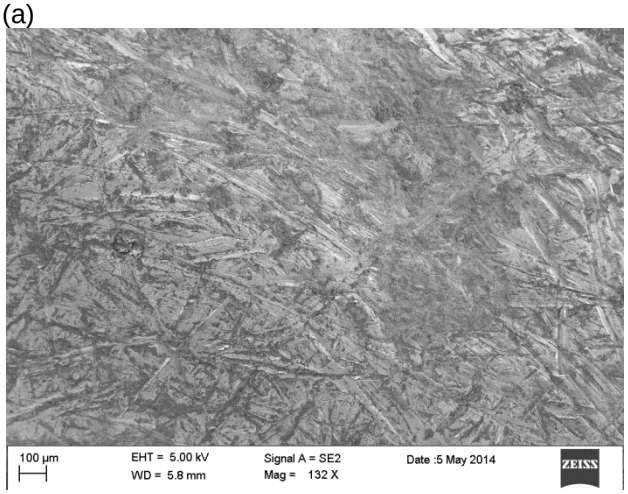


Figure 6. Cracks on WC grains (white circles)

Plastic deformation: The continuous cutting process facilitates high temperature generation on tool. Scratches are formed due to interaction of tool with harder rock/coal material. Figure 7(a) shows the scratches on the body of pick. In the high temperature, as the number of impact on the tool increases, it becomes plastically deformed and the scratches get larger and convert into passage in which coal gets interrupted (figure 7(b)).

(a)



(b)

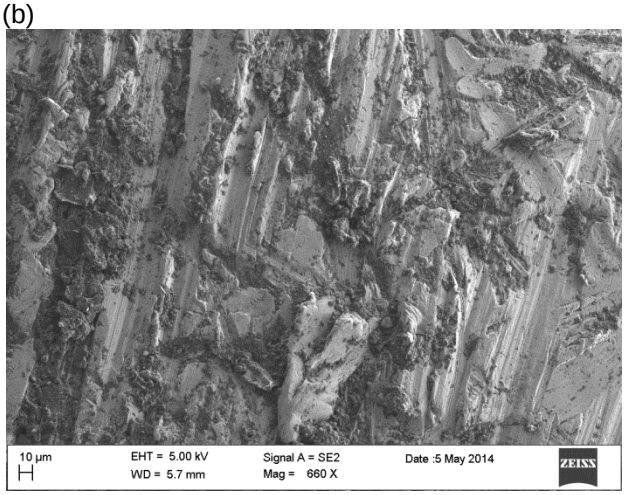


Figure 7. Plastic deformation on tool: (a) scratches on tool surface; (b) scratches enlargement and passage creation

5. Energy dispersive X-ray analysis

The material concentration on the worn out area of the tool has been observed by using energy dispersive X-ray analysis. For this, any point or area of deformed surface is selected and the respective proportion of element (whichever is present) is found. In the present study, mainly Fe, O, Al, K and Ca have been observed, although other elements like Si, Na, Mg and Cl have also present in small amount.

An area (spectrum 1) has been selected from the tip removed zone of pick and corresponding material concentration is shown in figure 8. Carbon, oxygen, calcium and iron are present in excess. 'C' represents the coal material and 'O' and 'Ca' are the sign of presence of rock material. Although WC-Co tip is removed, small amount of W and Co are also available.

A coal interrupted area has also been analyzed by EDAX. A point (spectrum 7) has been selected and it has been observed that C, O, K and Ca are in excess which indicate the presence of large amount of coal and rock material. Fe, Na and Mg are also available in small concentration. Here, W and Co are not present (figure 9).

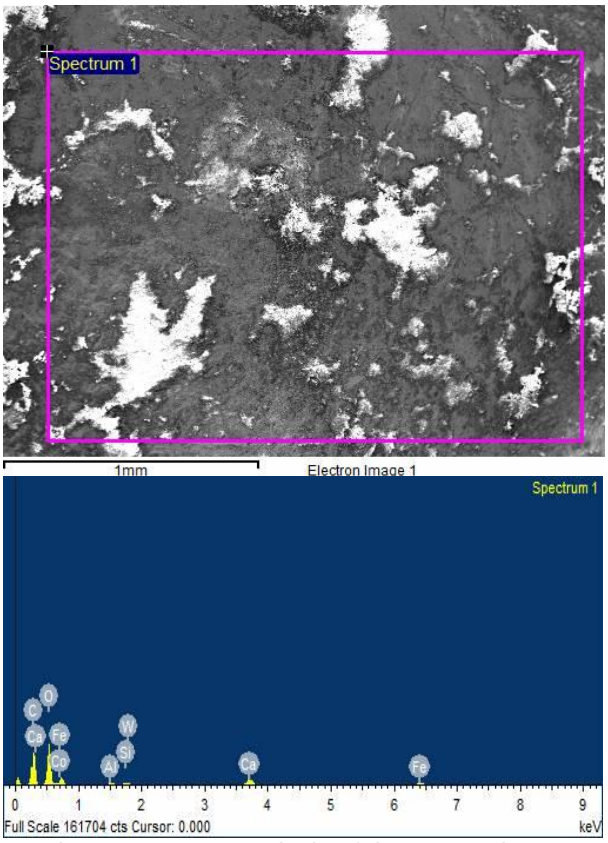


Figure 8. EDAX analysis of tip removed area

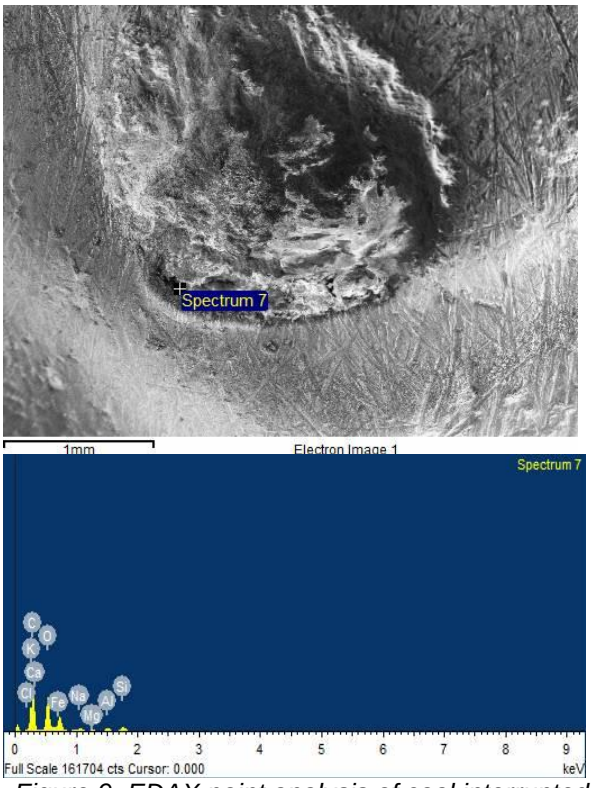


Figure 9. EDAX point analysis of coal interrupted zone

6. Conclusion

On the basis of literature review it can be concluded that conical pick is more advantageous than other shaped tools. The high production rate and comparatively more wear resistant phenomenon vouch for the usefulness of the conical peak. The irregular shaped coal/rock present in mine imposes severe impacts and shocks on tip and body of pick and thus it is deteriorated. The sharp rock present in between the coal instigates the breakage of the tool tip.

Through experiment it is found that the deterioration of conical picks has been occurred to a great extent. In several cases it has been observed that the complete conical tip has been eroded and severe body crushing took place on a worn out pick. A critical inspection of deteriorated sample is done by scanning electron microscopy (SEM) and energy dispersive X-ray analysis (EDAX) and different types of deterioration mechanisms have been observed namely: coal/rock cover formation, coal intermixing, cracks on WC grains and plastic deformation. The coal intermixing process with the bit material is highly undesirable as it replaces the Co phase. Sometimes the coal particles mix with binder phase and degrade it.

EDAX analysis reveals the availability of coal and rock material in tool. Mainly Fe, Co, Al, K and Ca are in excess quantity, although small amount of Si, Na, Mg, Cl, W and Co are also present in the deteriorated zones.

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THE EFFECT OF THE PARAMETRIC CNC PROGRAMMING FOR THE DRILLING TOOL LIFE

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Abstract
The shape of the chip and its removal from the hole has a major importance at CNC machines. To solve this problem, the manufacturers of CNC controls provide several solutions for the users. In the most often used controls the programmed drilling cycles are inflexible and do not take into consideration several technical parameters and there is no possibility for optimization on behalf of the user. The present work concerns the optimization of drilling cycles. The movements of the drilling tool is programmed using parameters, thus the user can benefit of a more flexible drilling cycle that takes into consideration several technical parameters.

Keywords:
drilling cycle, parametric programming, tool life

1. Introduction

During milling shaping the bores takes up significant machine time by the manufacturers. For reason CNC control manufacturers have developed a number of drilling cycles for the users, in order to optimize the time, which is needed for manufacturing. The most important task when drilling holes is the removal of chip. If this is not solved the drilling-process and the quality of the hole is in danger. The shape can be accepted, if the chip can freely move away from the hole. CNC machine operators can decide from the shape of the chip and sound effect, if the burr sticks in a half-opened burr-area boring tool. The shape of the burr can be highly influenced by the processed material and the applied technological parameters.
We have to be careful by the manufacturing of deep-hole, because the tool works in a difficult condition. In this case the tool has to have an "inner" cooling system, in order to be able to wash the burr out of the hole. By deep-holes it is recommended to make ca. 2xD depth (D hole-diameter) pilot-hole. We have to make sure that the pilot-hole's shape has to have the same profile and nominal diameter as the main-hole. It is common that we do not use pilot-hole. In that case the drilling has to begin with a low cutting speed (v_c=45 m/min) and a very low feed rate (f=0,02 mm/rev). Then we increase step by step the cutting speed and feed rate. Tool-manufacturers are giving similar pre-drilling advices for irregular and rough surfaces. At this time we have to decrease the technological parameters to ¼ comparing to the standard values. By the FANUC's type controllers two drilling cycles were developed for deep-hole drilling. The first graph shows a motion relationship of a high speed and deep drilling cycle. (Comment: The NCT's type controllers are popular FANUC's type controllers in Hungary.) The standard deep-hole cycle is different. After every down-drilling "Q" length, the drilling tool is lifted up by the controller from the hole in order to remove the chip safely.

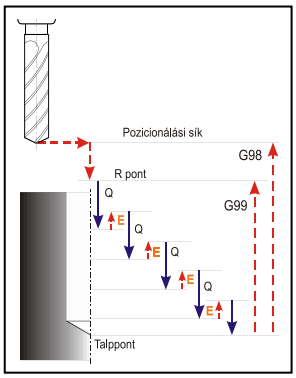

Figure 1. The motion elements of high speed drilling cycle

In both cases the programmable parameters are bounded. The users have no opportunity for many significant modifications. During drilling "Q" length is constant until the end. It can also happen that we face during drilling with other materials, where it is not necessary to pull out after every "Q" value the drilling tool in order to remove the burr. The value of feed rate and cutting speed cannot be changed freely.
With the help of macro program made by parametric programming we would like to make the hole-process more flexible at FANUC's type controllers and to increase the tool's cutting life and to decrease the machine time [1].

2. Macro for deep hole manufacturing

The real significance of the parametric programming is the making of the user macro. We call user macro those special sub-programs which does not contain any constant values. We use

variables during making macros. These are memory areas and register addresses with name. We can give those values or gather information about the operation and status of the system and the position of the carriage. Using variables the suitable dimensions can be parameterized, therefore the programs could be more flexible [1], [2].

Next, we introduce the variable length, self-cleaning deep hole macro in respect of the one stroke hole depth. It was one out of macros made and tested for FANUC type NCT104T and NCT201L milling control. These are under development in the CNC lab of Vehicle Technology Department of Kecskemét College.

The introduced deep hole macro can be suitable for milling control use with some modification. Primarily it gives solution for a serious problem during turning, where the drilling tool declared as revolving tool is in fact only seemingly a revolving tool. It can cause problem while removing burr. The burr during processing of holes in milling machine gets significant angular momentum, therefore it exits easily most of the times from the flute, using the available burned cycles. During drilling, which was made with turning technology, the real rotating working-piece does not - or just to a negligible extent - give angular momentum for the resulting burr. Therefore it is difficult to exit from the flute. It is a common problem by making small holes, when it is impossible to help removing burr with inner-cooling drilling tool because of geometric and technological reasons. If we use from burned cycles the simple deep drilling cycle, the problem can be solved but it slows down the hole procedure. For this reason it is suitable to use the deep drilling cycles in a simple way by 5L/D (Long/Diameter) ratio and more. In that case it is not recommended to choose the hole length of one stroke which has bigger diameter than the drilling tool. For example by 7L/D hole length it would be ideal, if it is drilled out to 4-5D in one stroke as it does not count as a deep hole. The remaining length would be made further one or two stroke.

In the developed macro we have developed the combination of FANUC type controller's used deep drill and high speed deep drill. We can influence parametrically the hole length in one stroke in it.

In this macro the basic technological parameters can be set: for instance the revolution, direction of rotation, feed rate, surface of working-piece, positioning and reference plane to the surface, drill hole in one stroke, retract after stroke. In addition to these we can make faster and more precise the procedure and we can increase the cutting life of the tool with the following parameters: waiting time, hole length in every stroke, decreasing the hole length in sequentially stroke, the smallest stroke's length, full pull out from the hole in a definite stroke number, waiting during the full pull out.

Additional parameters for calculation:

#121 = #107 (STROKE DEPTH)
#122 = #107 (HOLE DEPTH AT END OF STROKE)
#123 = - #105 (PULL DOWN POINT)
#124 = 0.0 (CYCLE COUNTER) for the full pull back

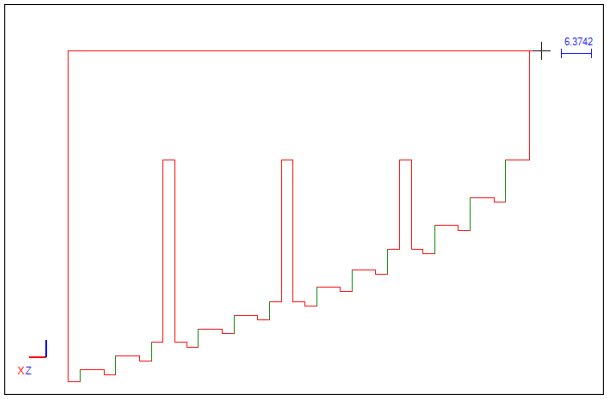

Figure 2. The motion process of the program

In the following table we can see the calculated positions of the macro for a 45 mm depth and Ø3 hole.

Table 1. The calculated parameter of deep drilled macro

Number of iterations.	#123 - 1st	#121 - 1st	#121 - 2nd	#122 - 1st	#122 - 2nd	#123 - 2nd	#124
1	-2.0	7.0	7.0	7.0	7.0	6.0	1
2	6.0	5.95	5.95	12.95	12.95	11.95	2
3	11.95	5.06	5.06	18.01	18.01	17.01	3
The drill pulled back to the reference plane, waiting for 0.5 s, then in fast movement back to Z-17.1							
4	17.01	4.3	4.3	22.31	22.31	21.31	1
5	21.31	3.65	3.65	25.96	25.96	24.96	2
6	24.96	3.11	3.11	29.07	29.07	28.07	3
The drill pulled back to the reference plane, waiting for 0.5 s, then in fast movement back to Z-28.7							
7	28.07	2.64	2.9	31.97	31.97	30.97	1
8	30.97	2.24	2.9	34.87	34.87	33.87	2
9	33.87	1.91	2.9	37.77	37.77	36.77	3
The drill pulled back to the reference plane, waiting for 0.5 s, then in fast movement back to Z-36.77							
10	36.77	1.62	2.9	40.67	40.67	39.67	1
11	39.67	1.38	2.9	43.57	43.57	42.57	2
12	42.57	1.17	2.9	46.47	45	42.57	2
The drill pulled back to the reference plane, end of macro, back to the main program							

Light blue	Colour indicates the unsolved datum by the program.
Light green	Colour indicates the overwritten datum by the program.
Light yellow	Colour indicates the reuncounted datum by the program.

- The #121 - 1st parameter counts the hole depth in one stroke, which is over written with the counted in #121 - 2nd parameter, if the #121 - 1st parameter's calculated value will be lower than the #2nd parameter, if the #122 - 1st parameter' calculated value will be higher than the #106 parameter's set hole depth value. We can avoid that the drilling cycle will not be unnecessarily long, which would cause the 111 parameter's set minimal value.
- The #122 - 1st parameter count the hole depth, which is over written with the counted in #121 - increase of machine time.
- The #123 - 1st parameter counts the approach point, which means in the first case the reference plane and in the following it agrees with the #123 - 2nd parameters counted pull back position.
- The #124 parameter's counts the number of iteration. After them the control executes a full pull out.

The program has the option that the drill waits every drilled hole depth - which can be beneficial milling hardly workable materials - and every full pull out - which improves the removal of the burr and provide enough time to cool the drill tool back - until the fulfillment of a specified revolution [1], [3], [4]. With this solution we can increase the cutting life of the drill.

For the production of macro program it is needed that we give an independent program number - belonging to the 9000 program-group. It is common to place macros which are fitted to the control in this program-group. For example measuring tool- and work-pieces, additional measuring cycles [3][4]. The program has the number %O9503 and the operator or the programmer receives the next parameter notes.

G65 P9503 S2900 M03 F0.1 A25.0 B25.0 R2.0 Z45.0 Q7.0 V2.0 E1.0 C0.85 U2.9 H3.0 W5.0

S	#19	(REVOLUTION)
M	#13	(DIRECTION OF ROTATION)
F	#9	(FEED RATE MM/FORD)
A	#1	("Z" POSITION OF DRILLEND SURFACE)
B	#2	(POSITIONING PLANE TO THE SURFACE)
R	#18	(REFERENCE PLANE TO THE SURFACE)
Z	#26	(HOLE DEPTH)
Q	#17	(DRILL HOLE IN ONE STROKE)
V	#22	(WAITING AFTER STROKE)
E	#8	(RETRACT AFTER STROKE)
C	#3	(STROKE DEPHT SHORTEN %)
U	#21	(THE SMALLEST STROKE DEPTH)
H	#11	(FULL PULL OUT AFTER „N"STROKE)
W	#23	(WAITING AFTER PULL OUT)

3. Summary

By this project, we would like to draw the attention of professionals in the manufacturing industry that during machining holes with the help of macro programing important machining-time can be saved. With our proposed technique the most important optimal technological parameters can be set, for example: cutting speed, feed rate etc. In addition, it is possible to describe the program for the necessary ideal movement of drilling tool. To describe the necessary ideal technological parameters for macro programming, a cutting experiment should be performed in all cases. In overall, using the above mentioned method there is a possibility to decrease the cost of manufacturing, as the cutting life of tool increases.

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EVALUATION OF SPRING BACK OF THE TAILOR-WELDED BLANKS IN „V" FREE BENDING PROCESS

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Abstract
Nowadays the range of used tailor-welded sheets is very wide in the automotive industry. The main aim of the usage of tailored blanks is to reduce the weight of the car in order to reduce fuel utilization and the emission of toxic gases.
When using tailored blank for automotive part production only that part of the car body is made of thicker and stronger sheet, which has to face higher stress.
The main problem in the process of forming tailored blanks is the behaviour of the parts, as the parts have different strength characteristics. The spring-back in the bending process is mainly influenced by the strength of the sheet, the ratio of the bending radius and the thickness of the sheet. The critical question is to predict the spring-back when we want to produce tight tolerance car-body.
The goal of our research work is to examine the behaviour of the tailored sheets used in automotive industry in aspect of spring back of them.

Keywords:
metal sheets for car industry, free bending process, spring-back in „V" bending

1. Introduction

In automotive industry one of the most focused questions is to reduce the weight of car bodies. In case of lighter car-body on the one hand the fuel assumption and toxic gas emission will be lover level. On the other side weight reducing cannot cause the reducing of safety of the people. For example using thinner sheets for car body components production, they have to have much higher strength. During last decades there was a very intensive development in the field of materials of sheet metals, which can be used for car-construction. There are some new developed high strength (HSS) and ultra-high strength steel (UHSS) sheets. There is problem when the strength of steel sheets increases the formability of them decreases [fig.1.]

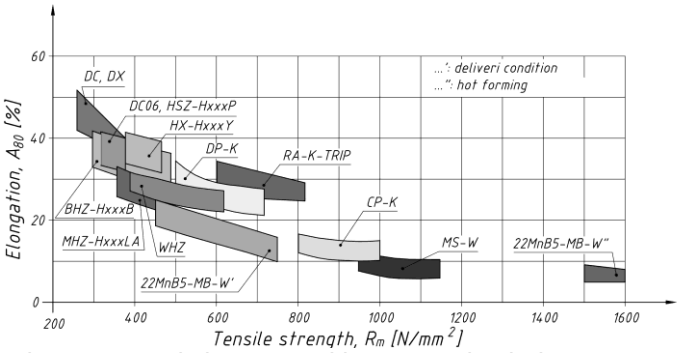

Figure 1. Steel sheets used in automotive industry

Generally the parts of car body construction are very odd shaped. Because of it the high strength of the sheets has to be accompanied with high level of formability too. When using tailored sheets the different sections of the tailored sheets show different behaviour during the process. The sections of tailored sheet blank in bending process show different spring back.
When we join a component made of tailored sheets with other part components the different spring back value of them causes problems.
In frame of our research work we examine the spring back of tailored sheets in bending process.

2. Car-body part made of tailored blanks – examples

"B" pillar of the car made of different thickness steel is shown in the [fig. 2.]

Figure 2. "B" pillar of the car made from tailored blank

The car floor panel made of tailored blanks is shown is [fig.3.]

Figure 3. Floor panel of the car, formed from tailored sheet

The car parts shown in above have very complex odd shapes. On them bent and deep-drawn sections can be found too. In case of producing them from tailored blanks their different sections show different spring-back behaviour. The compensation of the spring back arising in one formed part seems to be problem in aspect of tooling and assembling too.

3. Experiments in spring back evaluation

In this report the results of the experiments will be shown, which are carried out to determine the angle of spring back in case tailored blanks welded from sheets having different strength.
The main parameters effecting on extent of spring back are:

- material quality and state of the sheet material
- thickness of the sheet
- radius of bending
- ratio of bending radius and sheet thickness
- the speed of bending operation

Experiments were performed in three point free bending device is placed on the press brake machine type of AMADA HFE 50-20 demonstrated in Fig.4.

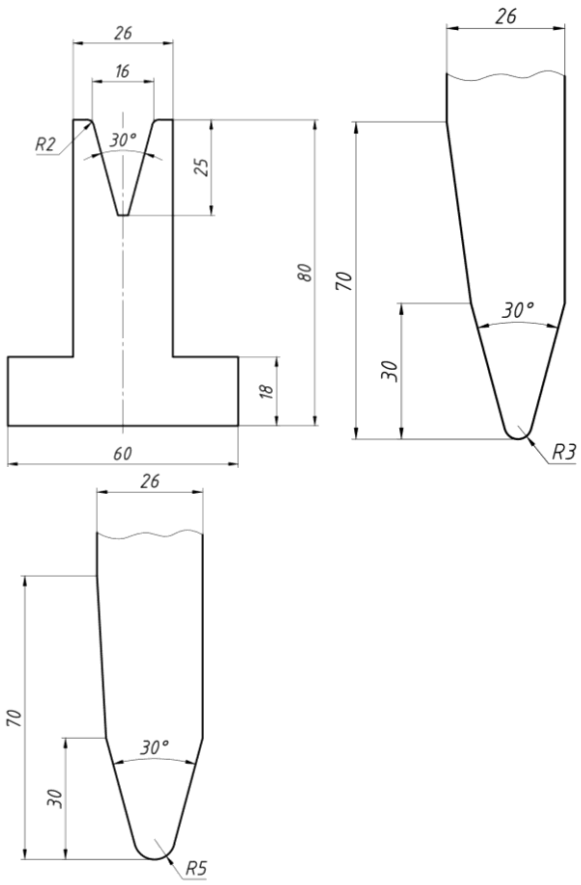

Figure 4. Free bending device placed on CNC controlled bending machine type of AMADA HFE 50-20

The angle required (90 grad) was obtained by computer of CNC controlled bending press. All bending experiments were absolved at the MATIC Ltd. This firm is one of industrial partners of Kecskemét College in this research program.
The fundamental mechanical properties of the sheets being bent is shown in the table below.

Table 1. Mechanical properties of the examined sheets

Material	Th.ness [mm]	Re [MPa]	Rm [MPa]	A80 [%]	z[%]	n	r
DC04	1	179,2	311,7	43,3	55,9	0,221	1,14
DP450	1	345	468	25,4	60,2	0,166	1,08
DP600	1	450,6	678,7	19,7	70,5	0,144	0,708
DP800	1	603,6	878,2	12,7	57,5	0,102	0,758
DP1000	1	730,7	1050,1	11,3	52,8	0,097	0,733

4. Results of bending processes of homogeneous sheets

In Fig. 5 demonstrated bent parts of homogeneous sheets. Bending processes were carried out by bending radius 3 and 5 mm too.

Figure 5. Bent part from homogeneous steel sheets with bending radius 3(left) and 5m too.

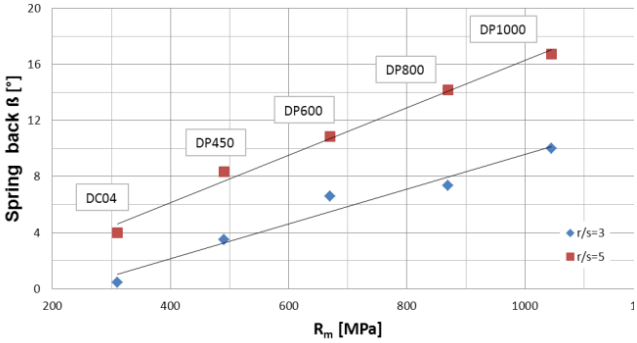

Figure 6. Angles of spring back in case bending of homogeneous sheets

5. Results of bending of the tailor welded sheets from different strength

In order to evaluation the value of angle of springback of the welded blanks in "V" free bending process were made blanks from different strength steels. It was supposed the different steels affect on each other in aspect of springback too. The blanks were made of different width parts. The aim was to measure angles of springback in different distance from the weld line.The sketch of initial blanks is shown in Fig.7

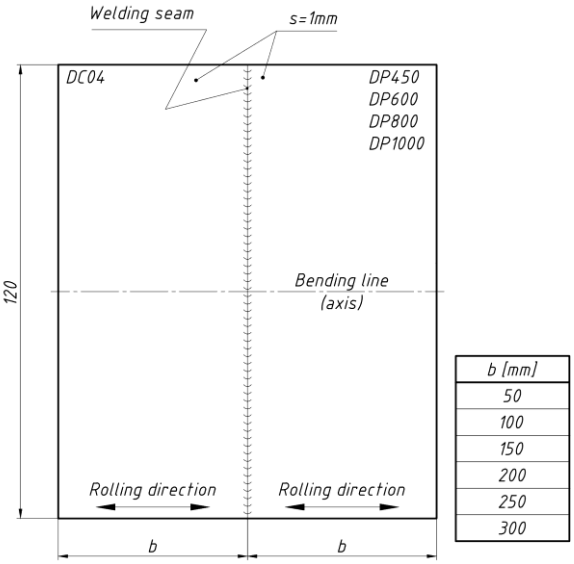

Figure 7. Initial blanks for evaluate angle of the springback of the welded sheets from different strength steel sheets.

The angles of spring back in bending process of tailor welded sheets is shown if Fig. 8. in Appendix. In bending of tailor welded sheets having different strength the joined parts effect on each other. Because of it is interesting to messure the spring back angle in the different distence from the weld line.To measure this behavior of initial blank were prepared whith difference length.
The different length bent part is shown in Fig. 8. in Appendix.

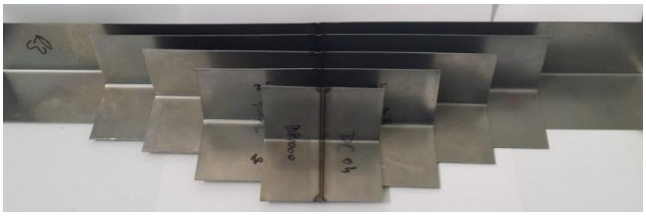

Figure 9. Different length bent parts made of tailor welded blanks

6. Conclusion

- Our experiments in bending of tailor welded sheets verified the former skills in bending and spring back.
- The different strength parts of the tailor welded blanks affect each other conversely in bending operation. The extent of the spring back angle near to the weld seam is between the spring back angles of the individual sheets.
- far to weld line about 300 mm the value of spring back angle are near to spring back angle of individual sheets
- The different angles of spring back in one bent part cause special problems in aspect of technology and in tooling of bent part production.

Acknowledgement

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Appendix

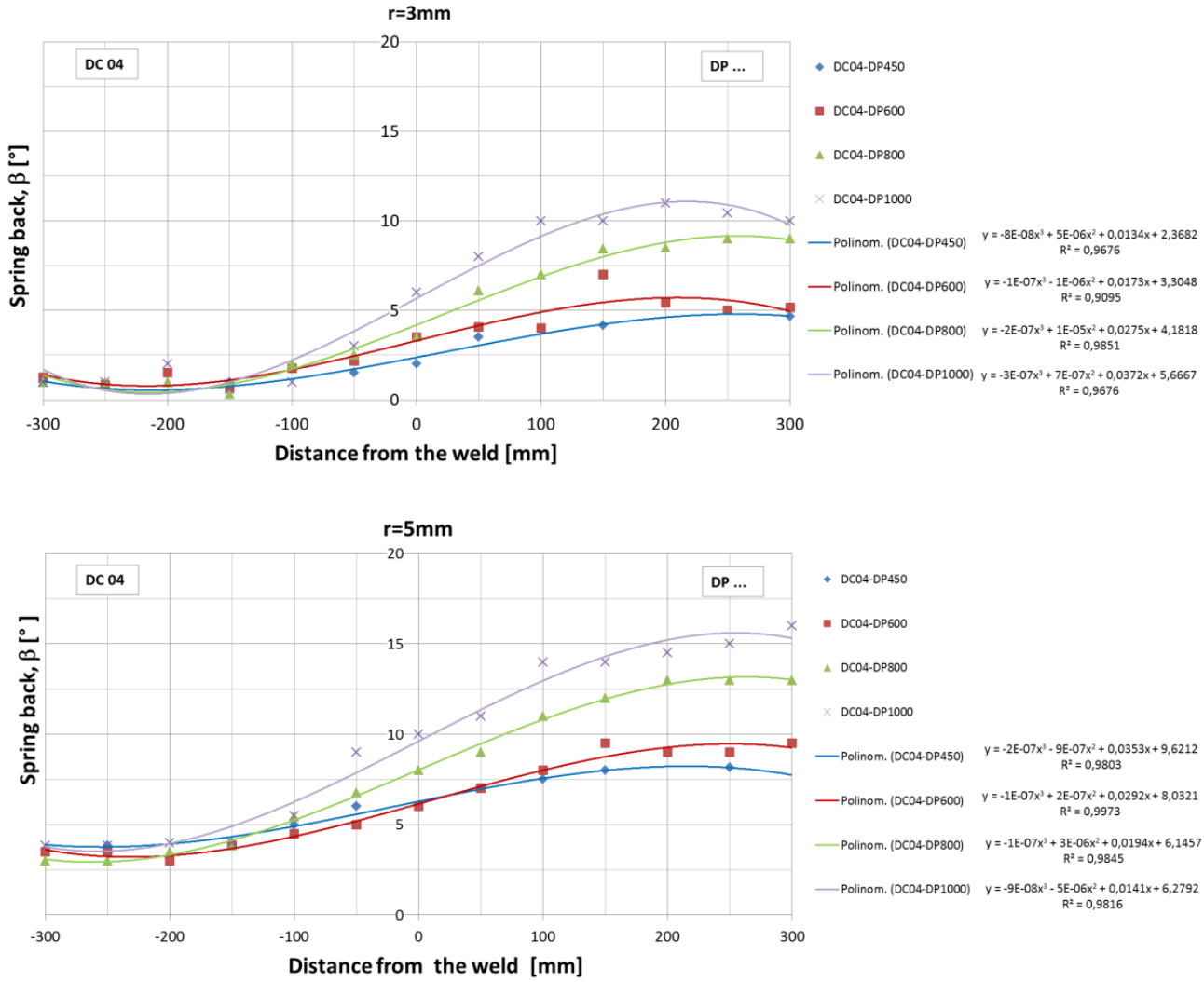

Figure 8. Angles of spring back in bending of tailor welded sheets

STUDY OF METAL SPUN PARTS SURFACE LAYERS TOPOGRAPHY

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Abstract
The paper brings the results of surface topography analysis of formed parts produced by CNC multi-pass conventional metal spinning. The influence of spinning feed ratio and workpiece geometry on the roughness of formed parts made of mild steel type of EN 10025-94 (ISO 630-80) have been studied by 3D surface mapping and evaluating. It is shown that the optimal feed ratio exists within the range of minimal and maximal feed ratio values and the surface roughness measured in different areas of experimental samples (corner R10, conical area, cylindrical area) indicates that the higher surface roughness occures on the conical surfaces.

Keywords:
metal spinning, surface, topography

1. Introduction

Sheet metal spinning is one of the forming processes based on gradual shaping of metal blank into an axisymetric part by a roller according to a mandrel. Due to its incremental forming feature, metal spinning has some unique advantages. The total forming forces are reduced significantly compared to conventional press forming. This increases the possibilities in terms of large reductions and change in shape with less complex tooling and also reduces the required load capacity and cost of the forming machine. Very significant feature of spinning is ability to produce components with high mechanical properties and smooth surface finish.

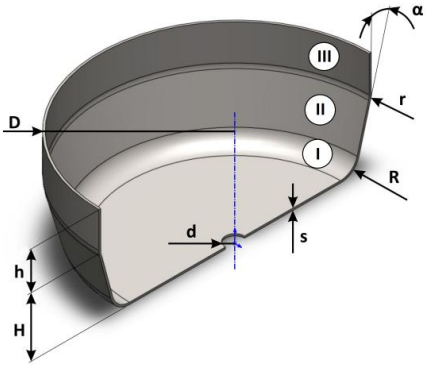
Although knowledge about mechanics of spinning, which helps to understand final properties of spun parts, have been developed by systematic investigation of the process using both experimental and theoretical techniques, several gaps still exist in the prediction of the product properties. [1]

Studies of the relationship between surface roughness and process parameters have been concentrated maily on shear spinning ([2], [3] and other). For conventional spinning, El-Khabeery et al. [4] studied the effect of machine parameters and tool on surface roughness. They report that lower feed rates and larger roller nose radius produce better surface roughness. Lower feed ratio would result in a better surface finish, but in order to maintain the original blank thickness unchanged, high feed ratios should be used. It may be necessary to find a "trade-off" feed ratio, which not only can help to maintain the original blank thickness unchanged but also prevent the material failures and produce good surface finish [5], [6].

In order to increase knowledge about metal spun surface microgeometry formation the series of experiments were carried out. The influence of feed ratio and workpiece geometry of the sheet on the surface roughness was observed.

2. Methods and materials

For production of experimental samples, which shape and dimensions are demostrated in Fig. 1, have been used circular blank with an outer diameter of D_0 = 200 mm, prepared by AWJ machining technology. The used sheet has been made of mild steel, defined in the standards EN 10025-94 (ISO 630-80). Basic mechanical properties and facilities defining material plasticity (ultimate tensile strength (R_m), 0.2% offset yield strength ($R_{p0.2}$), elongation (A_5), medium value of normal anisotropy (r_s), planar anisotropy (Δr) and strain-hardening coefficient (n)) shows Tab. 1.



D (mm)	140	R (mm)	10
h (mm)	20	d (mm)	10
H (mm)	30	α (°)	15
r (mm)	10	s (mm)	1

Figure 1. Experimental sample
I – radius R10, II – conical part of the workpiece, III – cylindrical part of the workpiece

Table 1. Mechanical characteristics of experimental material

R_m (MPa)	$R_{p0.2}$ (MPa)	$R_{p0.2}$ / R_m (-)	A_5 (%)	r_s (-)	Δr (-)	n (-)
340	235	0.69	26	1.174	0.34	0.28

The experiments were conducted on DENN spinning machine of the type Zenn-80 with a Sinumeric 840-D CNC control unit. A roller radius R8, constant mandrel speed 600 min^{-1} and three different levels of feed ratio (spindle speed/feed rate) have been used for all of the experimental trials. The off-line designed involute CNC roller paths profiles have been applicated: 9 movements towards the blank edge (forward passes), 3 movements towards the mandrel (backward passes) and one forward calibration pass. For friction reduction and surface quality improvement the lubricant oil of type AVIA GLEITBAHNÖL RSU 220 has been applied.
Taylor-Hobson profilometer was applied for roughness measurements and 3D surface texture analysis in three different places of workpiece (three different spun shapes: I – corner R10, II – conical area, III – cylindrical area) has been done (Fig. 1).

Two variables, i.e. feed ratio and workpiece geometry, were considered as the experimental input factors according to Tab. 2.

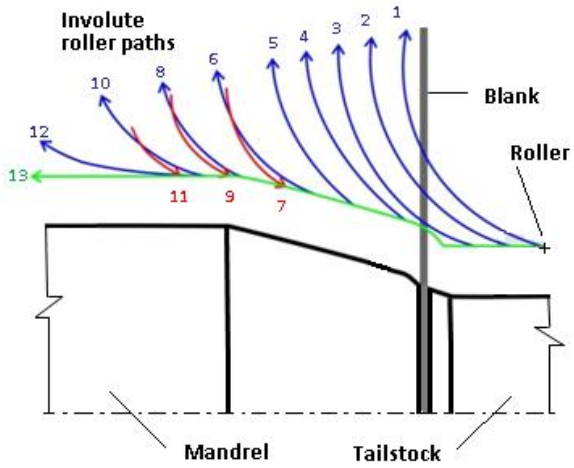


Figure 2. CNC roller paths

Table 2. Control factors and levels

Parameter	Sign	Level 1	Level 2	Level 3
Feed ratio (mm/rev)	*f*	1	1.5	2
Workpiece geometry (-)	*pm*	(I) radius R10	(II) conical area	(III) cylindrical area

3. Results and discusion

The results of spun parts surfaces roughness measurement are listed in the Tab. 3. The Ra roughness parameter in the three different places on measured area 5 x 5 mm has been evaluated and arithmetic mean of roughness has been calculated. The images, preseneted in Fig. 3 to Fig. 8, give a view on the surface topography of spun parts in three measured areas. Only the minimal and maximal roughness are showed.

.

Table 3. Results of measurement – surface roughness

Place of measure	Feed ratio	Ra profile 1 (10^{-6}m)	Ra profile 2 (10^{-6}m)	Ra profile 3 (10^{-6}m)	Arithmetic mean of roughness (10^{-6}m)
I	1	1.8	1.58	1.59	**1.66**
	1.5	1.04	0.818	0.923	**0.93**
	2	0.962	1.04	0.961	0.99
II	1	1.61	1.57	1.11	1.43
	1.5	1.4	1.41	1.09	**1.30**
	2	1.64	1.49	2.37	**1.83**
III	1	1.77	1.42	2.3	**1.83**
	1.5	0.908	1.05	1.19	**1.05**
	2	1.4	1.98	1.43	1.60

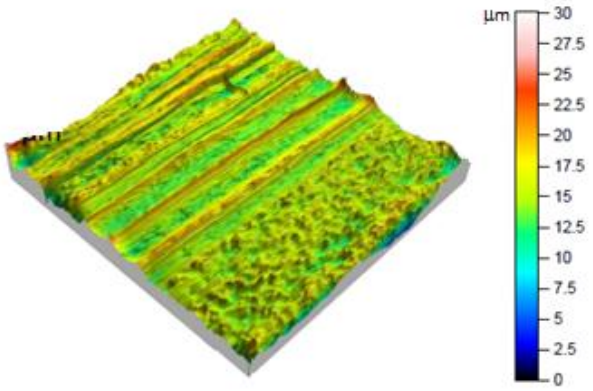


Figure 3. Surface roughness image – maximal roughness in area of radius R10
Lc = 0.8 mm, measured area = 5 x 5 mm)
(f = 1 mm/rev, Ra 1.66)

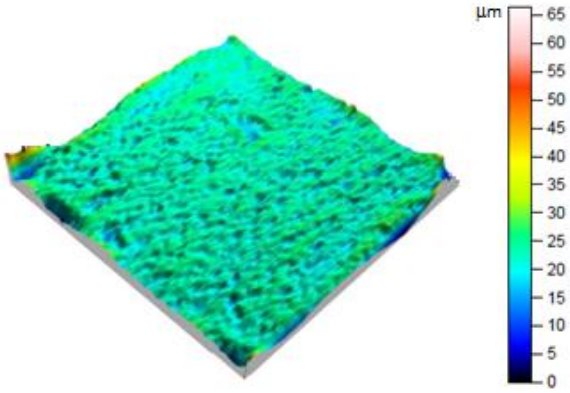


Figure 6. Spun part surface with minimal roughness in conical area
Lc = 0.8 mm, measured area = 5 x 5 mm)
(f = 1.5 mm/rev, Ra 1.30)

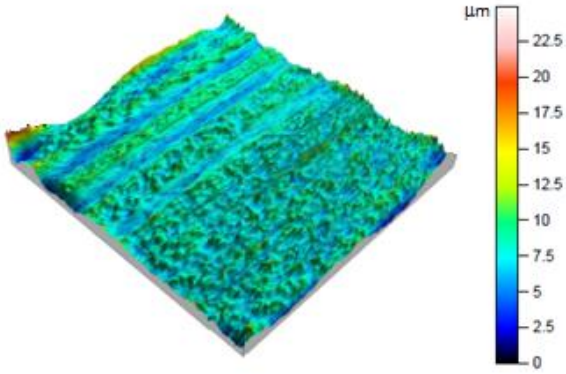


Figure 4. Spun part surface with minimal roughness in area of radius R10
Lc = 0.8 mm, measured area = 5 x 5 mm)
(f = 1.5 mm/rev, Ra 0.93)

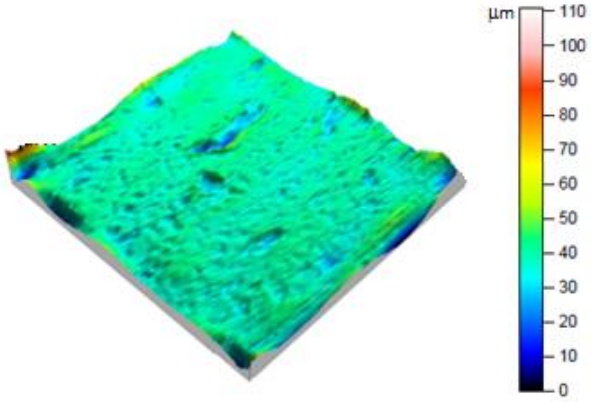


Figure 7. Spun part surface with maximal roughness in cylindrical area
Lc = 0.8 mm, measured area = 5 x 5 mm)
(f = 1 mm/rev, Ra 1.83)

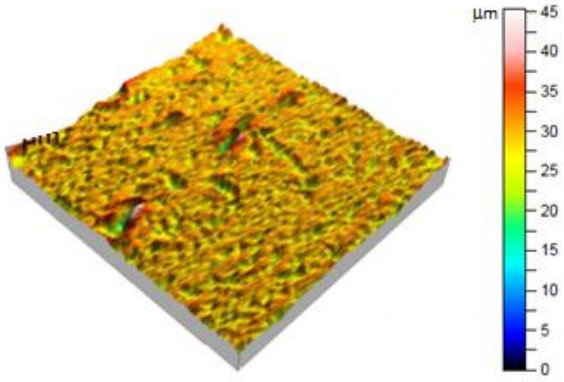


Figure 5. Spun part surface with maximal roughness in conical area
Lc = 0.8 mm, measured area = 5 x 5 mm)
(f = 2 mm/rev, Ra 1.83)

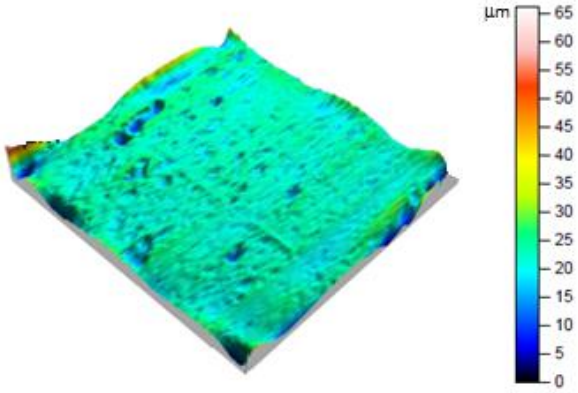


Figure 8. Spun part surface with minimal roughness in cylindrical area
Lc = 0.8 mm, measured area = 5 x 5 mm)
(f = 1.5 mm/rev, Ra 1.05)

Generally it can be told that lower values of surface roughness have been observed in the area I of the spun part – radius R10 and higher values have been documented in the areas II – conical part and in the area III – cylindrical part. Maximal values of roughness, in all measured places, were reached in these cases when the feed ratio has been 1.5 mm. On the other hand the surface topography in the areas II and III are more uniform and the surfaces seen to be "porous" without high peak and deep valey.

The results of the experiments showed that there is a optimal value of the feed ratio which gives us the best surface finish. It is no minimal nor maximal value of the feed ratio evaluated range. These results are not in agree with the general theory based on statement that higher feed is accompaned with higher roughness. Regarding the phenomenon of minimal values of surface roughness in area of radius R10 it must be told that the spinning proces is affected by so called phenomenological parameters (mandrel speed, feed ratio, tool geometry, formed material properties and so on), but also fundamental parameters (normal stresses under roller, shear stresses, strain states) [6]. It explains the lower values of roughness in the areas, where the higher tensile stresses are introduced in the deformed surface layers due to the intense bending.

4. Conclusion

In this paper the effect of feed ratio on spun part surface topography of EN 10025-94 (ISO 630-80) steel has been studied. The major results may be summarized as follows:

Feed ratio is factor which relatively intensively influences the surface roughness of spun part, produced by conventional metal spinning technology. The linear correlation between the feed ratio and roughness (higher feed reflects in higher roughness) has not been confirmed. Optimal roughness has been obtained for midle value of feed rate from the used parameter range.

The experimental results also showed that the maximal roughness, from the workpiece geometry point of view, has been observed in conical part of the experimental samples. Minimal roughness has been measured in area of radius R10. It is accompanied with the fact of specific stress-strain state under roller and higher degree of tensile stresses in the part surface layer. This findings are in accordance with the research results of Grohe and Schäfer [7] who showed that the final spun part surface quality is influenced not only by contact forming caused by spinning roller (contact normal stress), but also additional tensil stresses are introduced into already formed areas of the part by the roller feed. Therefore every subarea of sheet is exposed to specific stress state which significantly influence the final quality of spun part surface.

Acknowledgements

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WETTING FEATURES OF AG-SN LIQUIDES AND THE PHASE STRUCTURE IN SOLIDIFIED STATE

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Abstract
We studied the evolving micro-structure and its correlation with the wetting features of the Ag-Sn alloys have been studied in the whole concentration range. The properties of the wetting contact angles show close correlations with the evolving phases during solidification. It was found that the quantity of saturation of some phases has great influence on the texture of the solidified drop.

Keywords:
wetting, contact angle, crystal orientation, texture, silver, tin

1. Introduction

One of the perspective families of lead-free solder alloy systems is based on the Ag-Sn binary system [1-4]. Among the many important physical and chemical properties of soldering alloys, the wettability represents a key parameter in the success of practical use. [5-10]. In the present paper, experimental results are presented directing the concentration dependence of the wettability of the liquid Ag-Sn alloy on graphite substrate.
In our previous experiments, we assessed that the contact angles between the drop and substrate don't change during the solidification, so the solid drop keeps its quantity.It was also experienced, that a strong, preferred <100> texture is developed near to thedrop-garphite interface, whichseems to be in correlation with the wetting mechanism. i.e., the evolution of special short range order in the solidified alloyhints to the pre-existingatomic ordering in the liquid which can be enhanced by a "cathalitic" influence of the graphite substrate. We actually studied the correlations between the micro-structural and wetting features of the solid drop in the whole concentration range of Ag-Sn alloy in this contrution.

2. Experimental

Alloys were prepared from high purity (4N) Ag and Sn, using induction melting in cold quartz crucible under inert (Ar) atmosphere. The graphite substrate was made from high purity, porosity free base material. The substrates were mechanically polished to Ra=0.23±0.005 μm, r=1.009±0.0005. Surface roughness was determined using a 3D laser profilometer (Rodenstock RM600 surface topography measurement system).
Wetting experiments were performed in a sessile drop equipment [11], taking the methodological issues summarized by Sobczak et al [12] into account. The graphite substrate and the alloy were positioned into the furnace at ambient conditions. The pressure was then reduced to 0.1 Pa at room temperature in the chamber. The vacuum was then filled by a 10^5 Pa 99.999 % Ar gas. This procedure was repeated 3 times. Following this, the temperature was raised to 1273 K at a rate of about 4 K/s. Since only a small portion of the gas chamber is heated, the pressure around the droplet remains at about 10^5 Pa during the measurements. Measurements were made at 1273, 1323, 1373, 1423 and 1473 K.
The time dependence of the contact angle was measured from the moment of time the required temperature was stabilized. It was experienced, that the contact angle independent of the holding time after 1 minute duration at a given temperature (thermal equilibrium). Similar time-dependent graphs were obtained for other alloy compositions and temperatures (not shown here). Based that measurements after 2 minutes of holding time were used in this paper. As will be shown below, the Ag-Sn/C system is non-reactive and non-dissolutive. Consequently, the equilibrium shape is established within 1 s for such low viscosity liquids and non-reactive liquids [13-19].
The contact angle was determined by fixing the shape of the droplet optically, subsequently processed by self-made automatic evaluation software in the Matlab environment. Although the uncertainty of this software was below 1 degree, the total uncertainty of the measured values was ±3°.

After the last measurement at 1473 K, the furnace was switched off and was left to cool to ambient temperature. This took about 40 minutes. After that, the furnace was dismounted and the sample was removed. The alloy sample was weighed before and after each experiment. The average weight loss was below 0.5 % for pure Ag and for all Ag-Sn alloys, except for pure Sn (1.5 %). The alloyed sample was mounted into a resin and one half polished. This half of the sample is used for additional investigations.
SEM investigations were carried out using JEOL-JSM25-SIII SEM equipment, in secondary electron imaging mode. The constituent elements were analyzed by a Bruker-Röntec EDS microanalysis system attached to the SEM. The excitation parameters were 25keV beam energy and 50-200 pA beam current. Quantitative results were obtained from the measured spectra by a no-standard QUANTAX P/B ZAF correction program. Additionally, XRD measurements were per-formed with a Philips X'Pert diffractometer and the profile fitting of the detected XRD patterns were carried out using the Pro'Fitt commercial program. The transmission electron microscopy (TEM) carried out with a Philips CM2.

3. Contact angle measurements

The solubility limit of Sn in Ag is below 10 at % around room temperature (See Fig. 1.). Within this limit solid solution is formed. Exceeding this concentration limit, the so called „α and β" Sn phases are stable, for which the crystal structure deviate from that for the a-solid solution.

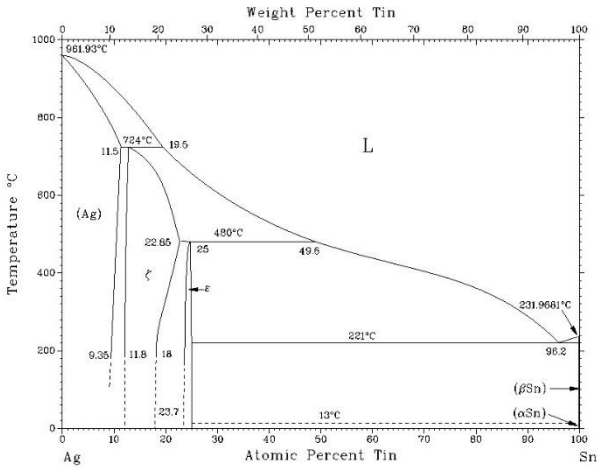

Figure 1. Ag-Sn equilibrium phase diagram [20]

The change of contact angles (on graphite substrate) as a function of Sn concentration (Fig. 2.) follows the appearance order of the balance phases pictured on the phase diagram, in case of alloys of different Ag-Sn concentration.

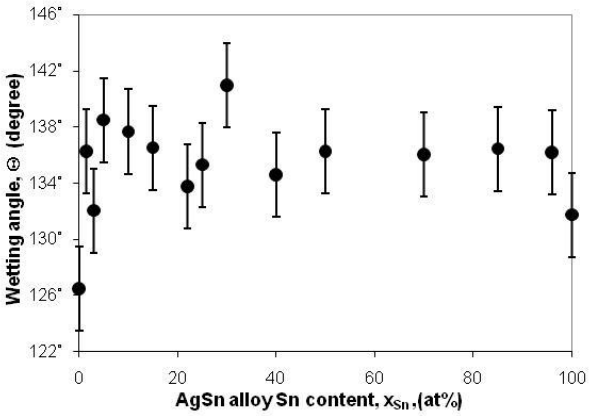

Figure 2. The concentration dependence of the measured contact angle at T = 1373 K

In the region folow Sn content (up to 5%) the contact angles increases. This increase is not monotonic however local maximum exists at around at 1.5%. Between 5% and 22% the contact angles decreases and,except the local minimum at 22%, it keeps the increase until a maximum at 30%. Rather small change can be detected between 40 and 100%, which fits the phase relation, because no new phase appears here., The ratio of phases changes only, required by the concentration change.

4. XRD measurement results

The XRD measurements were performed on the cut surface along the sheet illustrated in Fig.3. supplying information about the coexisting phases.

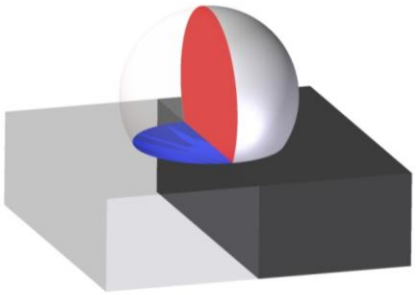

Figure 3. XRD measurements were performed between the substrate and the drop

In the Fig. 4. the XRD intensities are illustrated as a function of 2Θ, measured on pure silver, $Ag_{98.5}Sn_{1.5}$, $Ag_{97}Sn_3$, $Ag_{95}Sn_5$ samples respectively.

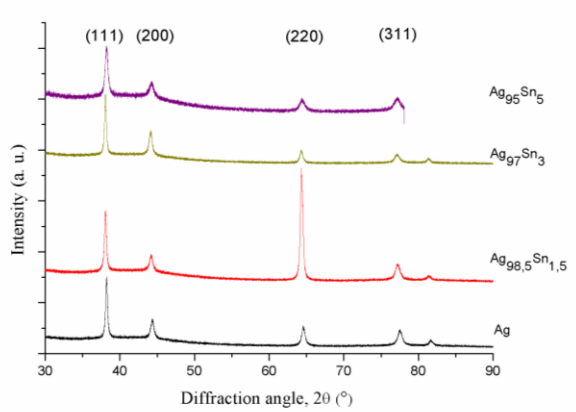

Figure 4. XRD results of Ag- $Ag_{95}Sn_5$ alloys

According to this Fig.3, the position of diffraction intensities fits to the pure silver's FCC structure in the investigated concentration range, supporting clearly the solid solution character of the solidified drops. The intensity scale of diffraction maximum are also supported by the reported data, published on appropriate powder patterns (ASTM 04-0783), showing, that the orientations of FCC grains are random.

The only exception is the $Ag_{98.5}Sn_{1.5}$ sample, which has a definite <110> texture, because its (220) reflection is more intensive, than the (111). The reason of this unique orientation can be the consequence of preferential incorporation Sn atoms (in the surface layer). In case of higher Sn concentration the FCC structure (with Sn atoms replacing the Ag atoms), the controlled incorporation and the preferential orientation of the crystallites break off. Perhaps this structural change causes the noticed "anomaly" in the magnitude of contact angles, namely the local intensity maximum at $Ag_{98.5}Sn_{1.5}$. In this concentration range the contact angles are higher than that for the pure Ag, which is understandable if we consider the increased surface-tension (because of the sudden increase of electron density) caused by the Sn solute atoms.

In the Fig. 5. the XRD spectrums are depictured for $Ag_{90}Sn_{10}$ - $Ag_{75}Sn_{25}$ alloys.

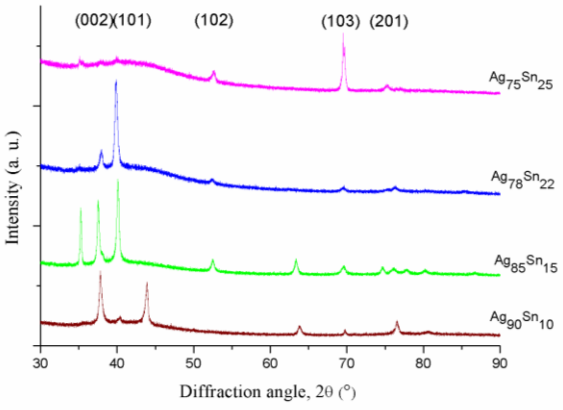

Figure 5. XRD results of $Ag_{90}Sn_{10}$ - $Ag_{75}Sn_{25}$ alloys

From the analysis of the, XRD patterns it can be seen, that the $Ag_{90}Sn_{10}$ sample has mainly FCC structure, so it has Ag(Sn) phase, but also contains a minimum of 1-2% Ag_4Sn phase too, because its most intensive reflections (101) and (103) appear in the XRD pattern. In the $Ag_{85}Sn_{15}$ sample the two kinds of crystallites coexist. In the case of $Ag_{78}Sn_{22}$ sample the detected intensity maximums fit the Ag_4Sn (ASTM, 29-1151) hexagonal structure. This phase is the so called ξ phase in literature (Fig. 1.). Lattice parameters are: a=0.2966 nm, b=0.4782 nm. The measured intensity scales fit the measured reference data taken on the powder pattern, showing that the orientation of grains are random. It is remarkable, that the appearance of this intermetallic phase decreases the contact angles, representing the improved wettability on the graphite substrate.

Comparing the XRD patterns of $Ag_{78}Sn_{22}$ and $Ag_{75}Sn_{25}$ alloys (Fig. 5.) the significant difference is obvious. In $Ag_{75}Sn_{25}$ Sn alloy the XRD measurements shows formation of new Ag-Sn phase (see on Fig. 5 and Fig. 6, XRD diagrams detected on $Ag_{75}Sn_{25}$ and $Ag_{70}Sn_{30}$ samples). The locations of intensity maximums fit the orthorhombic Ag_3Sn (ASTM, 04-0800) phase. Lattice parameters: a=0.2995 nm, b=0.5159 nm, c=0.5805 nm. Also this single phase was identified in the $Ag_{70}Sn_{30}$ sample, which indicates the +5% solid solubility of Sn in this phase. Comparing the XRD diagrams of the two samples, it is evident, that the additional Sn incorporation causes significant change in the peak intensities. The contact angles increases in this concentration range (between 25-30%.Sn). In consequence of the increasing electron density caused by increasing Sn content.

On Fig. 6 and 7 you can see the x-ray diffractograms measured on $Ag_{70}Sn_{30}$-Sn samples.

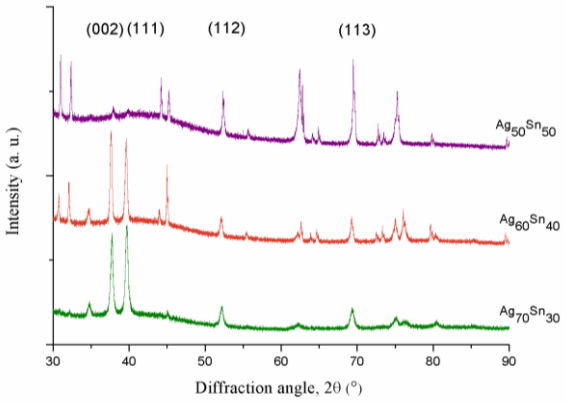

Figure 6. XRD results of $Ag_{70}Sn_{30}$ - $Ag_{50}Sn_{50}$ alloys

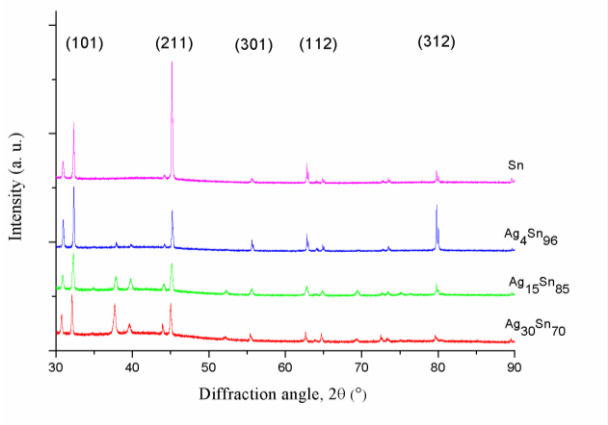

Figure 7. XRD results of $Ag_{30}Sn_{70}$-Sn alloys

In the $Ag_{60}Sn_{40}$ sample the Sn element appears as additional, individual phase together with the Ag_3Sn compound phase resulting the decrease of contact angle. As the Sn concentration further increases, the detected intensity maximums came from the above mentioned two different phases, which scale changes progressively. The Sn parameters are: a= 0.5831 nm, b= 0.3182 nm (the scale can be defined from the XRD measurements as an analysis of the line profile). In the Ag_4Sn_{96} sample the Ag_3Sn phase is hardly detectable.
The presented results fit qualitatively to the phase relations illustrated by the equilibrium phase diagram, so the progressive change of the contact angle can be explained based on this connection.
The questions are, whether this connection can be developed into a more quantitative form, when the coexisting phases are defined quantitatively including also the determination of Sn content in the individual phases. For this purpose, scanning electro-microscopic measurements and EDAX micro-analyses are performed in the solidified drops including also homogeneity study.

5. Scanning electron microscopic (SEM) measurements

The component distributions analyzed in the solidified drops with X-ray micro-analysis in scanning electro-microscope.
In Fig. 8-10.you can see the $Ag_{90}Sn_{10}$, $Ag_{78}Sn_{22}$, $Ag_{50}Sn_{50}$ the scanning micrographs are recorded on the surface cut perpendicular to the substrate.

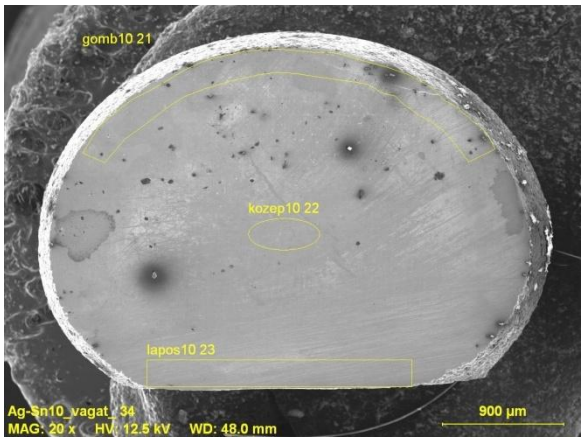

Figure 7. SEM picture from the $Ag_{90}Sn_{10}$ alloy drop

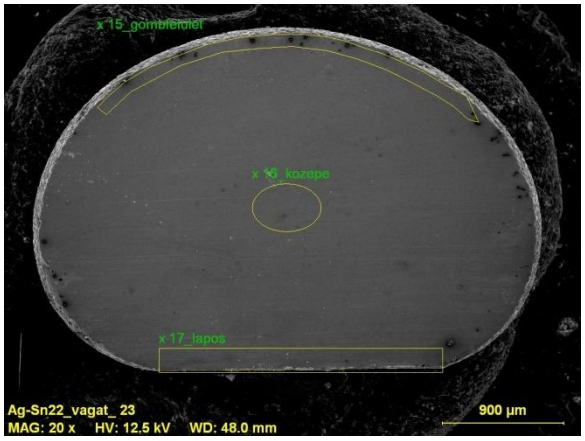

Figure 8. SEM picture from the $Ag_{78}Sn_{22}$ alloy drop

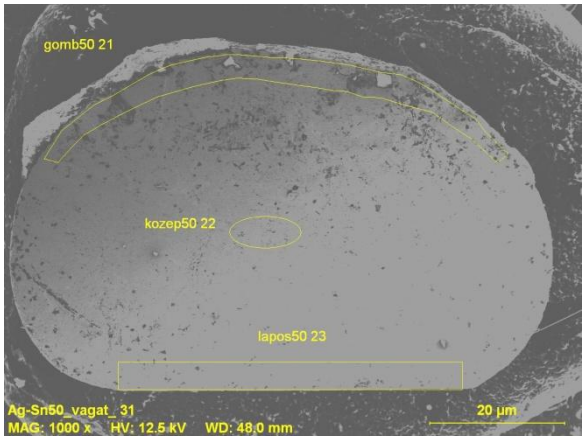

Figure 9. SEM picture from the $Ag_{50}Sn_{50}$ alloy drop

The results of the X-ray micro-analysis are collected in the Table 1. obtained, on the top, middle and bottom of the drop (see Fig.9.).
In case of $Ag_{90}Sn_{10}$ and $Ag_{50}Sn_{50}$ samples, the highest Sn concentration is detected in the middle of the drops, Contrary, in the $Ag_{78}Sn_{22}$ single-phased (Ag_4Sn) sample, the highest Sn concentration is found at the bottom of the drop.

Table 1. Results of the X-ray micro-analysis of $Ag_{90}Sn_{10}$, $Ag_{78}Sn_{22}$, $Ag_{50}Sn_{50}$ alloys

		bottom (at %)	middle (at %)	top (at %)
$Ag_{90}Sn_{10}$	Ag	89	87.2	88.4
	Sn	11	12.8	11.6
$Ag_{78}Sn_{22}$	Ag	72.7	74.1	74.2
	Sn	27.3	25.9	25.8
$Ag_{50}Sn_{50}$	Ag	42.6	38.2	42.4
	Sn	57.4	61.8	57.6

With the applied resolution during component analysis we could only reveal local concentration changing, without the detection so called phase separation in the $Ag_{50}Sn_{50}$ sample. The two other samples is homogeneous within the experimental error of measurements, which confirm the XRD results, indicating the single phase character of the $Ag_{78}Sn_{22}$ sample. (The role of second Ag_4Sn phase in the $Ag_{90}Sn_{10}$ sample is negligible, due to the low fraction). In Fig. 11. the X-ray map can be observed in the $Ag_{50}Sn_{50}$ sample

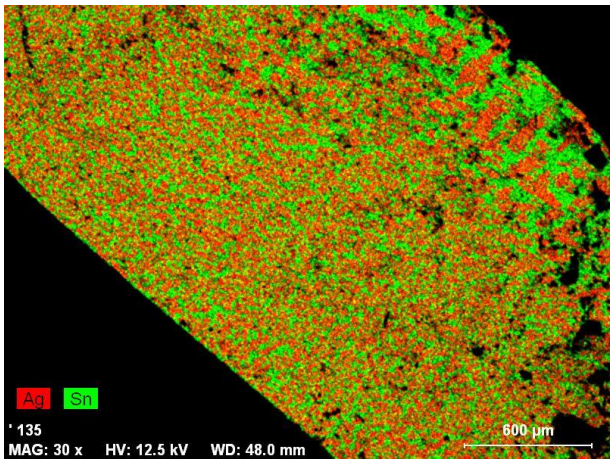

Figure 11. X-ray map of the $Ag_{50}Sn_{50}$sample

The coarsening of Ag and Sn rich regions is more pronounced in the vicinity the top of the solidified drop, demonstrating clearly the intensive segregation as the solidification proceeds. Based on Fig. 11. one can conclude also, that solidification starts via heterogeneous nucleation at the melt-substrate interface.
When higher resolution is applied, the two-phase nature is obvious in the whole volume (inner part) of the solidified sample (Fig. 12.).

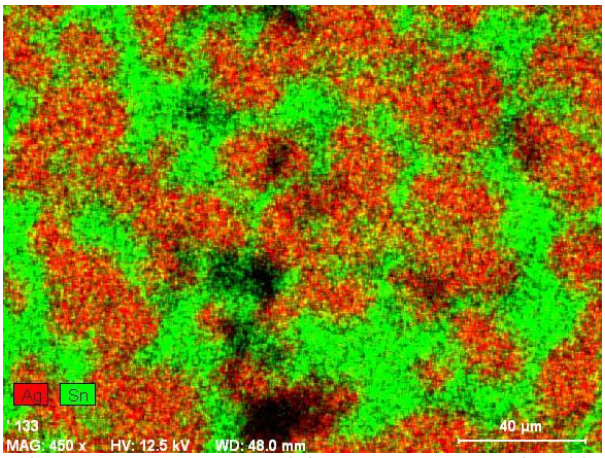

Figure 12. X-ray map of the $Ag_{50}Sn_{50}$ sample with higher resolution

Quantitative element analyses are also performed in selected areas of samples (see Fig. 12.). It was realized, that the concentration of Ag and Sn is slightly different in the “red and green” colored areas which means, that the Ag-content of the tetragonal Sn phase (detected with XRD) can slightly changes within a solubility limit.
In the Ag areas, the composition is actually ~74:26% Ag, which fits the composition of the orthorhombic Ag_3Sn intermetallic compound phase (detected with X-ray diffraction), although it has a minimum of ~1% Sn surplus.

6. Transmission electron microscopic (TEM) measurements

It was reported in previous paper, that the contact angles measured at 1473 K on liquid drop is nearly the same, as the measured values after solidification (room-temperature measurement). This means that the most favorable atomic arrangements have already been developed in liquid state prior to the formation of solid, crystalline nuclei at the interface. Our earlier result hints to the role of interaction between graphite and the drop, which shows that the evolution of pronounced texture around the interface vicinity of the graphite substrate has a close correlation with the contact angles which defines the drop’s shape, and the wetting.
TEM measurements showed that, the inner tensions during chilling are deduced by the drop with a typical imperfection The electro-microscope record (Fig. 13.) was made of the $Ag_{95}Sn_5$ drop’s core, and its eye-catching, that the twin lamella (which deduce the inner tensions) and the small-angled limits model a perpendicular reticulated pattern.

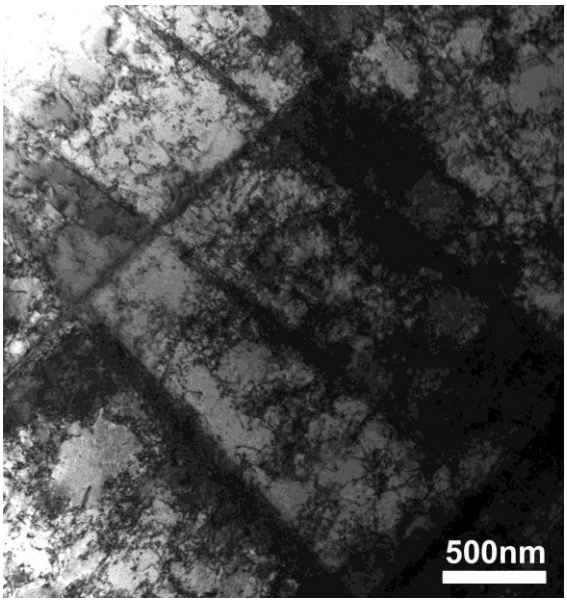

Figure 13. TEM picture from the $Ag_{95}Sn_5$ alloy

7. Conclusion

The evolving phases during solidifying in Ag-Sn alloys play an important role on changing the alloy's wetting features, which is not surprising, if we have a look at the drop's shape, which doesn't changes according to our measurements, so the order evolves during melt phase as a consequence of atomic interactions.

Our measurements pointed that not only the new phase brings significant changes in contact angles, but the saturation of different phases forming a solid solution.

Acknowledgement

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EFFECTS OF MULTIPLE REFLOWS ON WETTABILITY IN SN-AG-CU LEAD-FREE SOLDER ALLOYS

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Abstract
Surface conditions of Cu plates or Printed Circuit Boards (PCB) have an important impact on the wetting behavior with lead-free solder. The effects of different reflow numbers on wettability were examined. The wettability change of liquid Sn 96.5 Ag 3 Cu 0.5 solder alloy on Cu plates and PCB substrates were measured with sessile drop method at 523 K temperature. Wetting properties were determined in normal atmospheric air and inert atmosphere.

Keywords:
lead-free solder, wettability, wetting contact angle, reflow, copper, printed circuit board

1. Introduction

Soldering is the most popular joining technology in microelectronic and optoelectronic industries. The soldered products and the soldering technology are widely used in the vehicle industry [1-4]. Increasing global customer demand for miniaturised, hand-held and pocket electronic products has been a key driver in the design, development and wide application of high-density area array package format [5]. Electronics manufacturing industries have utilised advanced Integrated Circuits (ICs) packages such as Micro-Ball Grid Arrays (MBGA), Chip Scale Packages (CSP), Flip Chip (FC) technology and Surface Mount Device (SMD) to be able to achieve the manufacture of smaller, lighter, faster and cheaper products. However, the assembly of these surface mount packages and the reliability of the products are challenged by crucial manufacturing process steps. The use of ultra fine pitch packages makes the stencil printing process more critical to produce a reliable solder joint [6]. The most important step in the SMT (Surface Mount Technology) production process besides paste printing is the reflow soldering process [7]. The solder reflow profile is one of the key variables in the electronics manufacturing process that significantly impacts product yields [8]. The manufacturing challenges associated with both solder paste printing and reflow soldering increases as electronic device size decreases. At very small aperture sizes, the rheological dominancy of surface tension over paste viscosity impacts negatively on the printing process that is the reason of the increasing manufacturing difficulties. The outcome may include overfill of stencil cavity with solder paste. The consequence of this outcome may lead to printing defects such as solder slumping and bridging. A vital key to achieve urgent customer satisfaction on further miniaturisation of electronics with good solder joint reliability is the in-depth understanding of the solder paste transfer efficiency [9].

Due to worldwide environmental concerns, public sentiments and market strategies, as well as governmental regulations on the use of toxic Pb in the electronic products, the conventional Sn–Pb solders are under strict scrutiny. That is reason why many Sn-rich alloy systems have been developed as alternative candidate Pb-free solders, which have attracted several research and trial applications in recent years [10]. With a combination of process attributes (modest melting point and reasonable solderability), comparable electrical performances and good mechanical properties, the Sn–Ag–Cu system is one of the potential choices [11].

Although great effort has been made for more than 10 years to get the Pb out of electronic industry, until now, there are still some tough barriers need to override for a widespread and uniform industrial acceptance of favourable solder alloys and matched materials plus processes [12, 13]. Besides the lack of legislation, the high cost and insufficient backup data of Pb-free operation (compared to the well–established Sn–Pb soldering system) are cautious consideration nowadays [11].

In the soldering process, the molten solder wets the substrates, and the interfacial reaction occurs at the solder–substrate interfaces, thus forming the soldering joints. That is why the wetting property between solders and substrates is crucial to the reliability of the soldering joints [14, 15].

This study experimentally determines the wetting properties using the sessile drop method at normal atmosphere and at inert gas atmospheres and the

effect of the reflows. The wettability of solder paste was measured on different substrates.

2. Measurement method and examined materials

The technical measurements usually depend on many variables [16, 17]. The wetting angle measurement is complicated because several environmental variables are affect the results. The wetting experiments were performed in a wetting angle measuring system which can measure the wettability using sessile drop method (Fig. 1.) [18], taking the methodological issues summarized by Sobczak [19] into account.

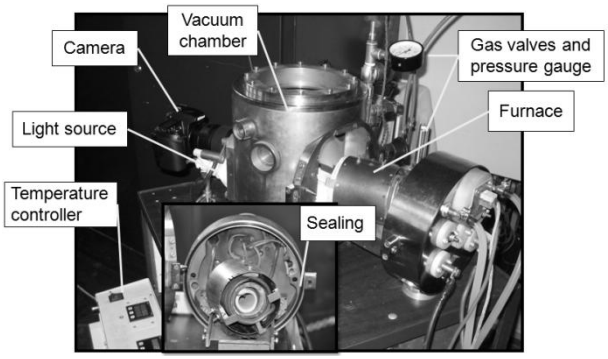

Figure 1. Wetting angle measuring system

The oxygen has bad impact on the accuracy of the wettability tests that is the reason why the chamber has changeable atmosphere [18]. The measurements can be performed in air or inert atmosphere. The heat required for the measurements provided by a resistance-heated tube furnace which can ensure the measuring temperature up to 1473 K. In this paper the measuring temperature was not high. The melting temperatures of investigated solders are below 523 K.

At the beginning of the wetting angle measurements the samples were positioned into the furnace at ambient conditions. When the measurements were performed in inert atmosphere, the pressure was then reduced in the chamber and the vacuum was replaced by a 10^5 Pa 99.999 % Ar or Ni gas. The vacuuming and the inert gas filling was repeated 3 times, to reach lower O_2 concentration in the chamber. When the measurements were performed in air atmosphere these vacuuming and inert gas refilling steps did not required. Thereafter the temperature was raised up to the measuring temperature. The contact angle values of the drop were measured directly from its images. The total uncertainty of the measured values was ±0,75˚.

The solder paste is a mixture of solder alloy powder and flux. The measurements were performed with Senju M705-GRN360-KV Lead-free SAC305 solder paste, which consist of Sn 96.5 Ag 3 Cu 0.5 solder alloy powder.

The wetting angle of solder pastes were examined on Cu-ETP R240 (CW004A) copper plates and tin coated PCB plates as substrates. This type of copper is widely used for electrical and electronic applications. Before the measurements the copper plates were grinded and polished to remove the oxide layer and reach similar surface properties and washed with 96 % ethanol (C_2H_6O). The other used substrate, the epoxy based PCB material has two copper layers, on the upside and on the bottom side. The copper layer thickness is approximately 35 µm and the immersion tin layer is directly deposited on the copper. The layer thickness of immersion tin amounts to approximately 1 µm. The Fig. 2. shows a cross section of the typical PCB configuration.

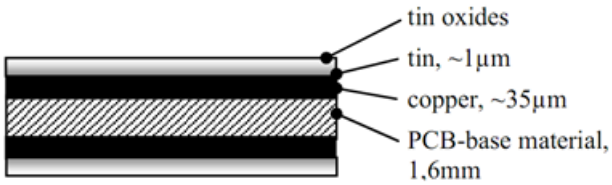

Figure 2. Cross section of a typical PCB configuration with immersion tin final finish [20]

The substrates which are reflowed more than one were prepared in the wetting angle measuring equipment. The substrates were heated up to the soldering temperature without solder paste that means one reflow. Before the last reflow the solder paste applied on the substrate surface. The wetting angle measurement is performed during the last reflow.

The investigated solder was Senju M705-GRN360-KV Lead-free Solder Paste. The Fig. 3. shows the investigated solder paste optimal soldering temperature profile.

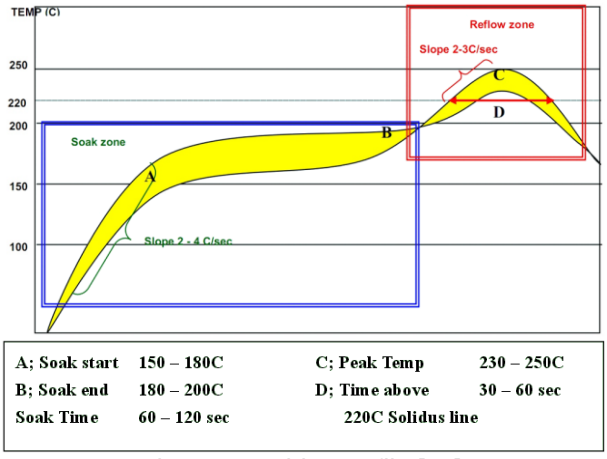

Figure 3. Solder profile [21]

At the reflows and the wetting angle measurements (which were examined at the point “C“) we used the above temperature profile.

3. Results

Two samples after the measurement process are shown in Fig. 4.

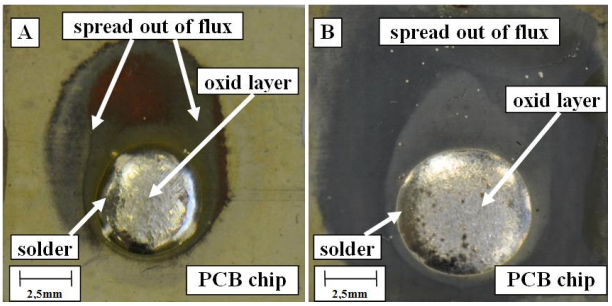

Figure 4. Solder spread test with lead free solder alloy on PCB

The molten solder created a lenticular shape in the top of the PCB chips and the flux spread the solder. The main reason of the different spreading in Fig. 4. was the oxidization of the immersion tin layer on the PCB chip. Sample A (in Fig. 4.) was made under air atmosphere and flux covers smaller surface of the PCB than sample B (in Fig. 4.), which was measured under Argon atmosphere. The flux couldn't spread the whole PCB surface because too much tin oxide formed under air atmosphere. Another oxide layer centralized on the top of the solder, which was formed by the oxygen content of the solder paste. This oxide layer was formed under both atmospheres so the measuring conditions had no effect for the formation.

Porosity is a common problem when using solder pastes and reflow soldering. There are a certain number of publications that explained the influencing factors on pore formation [22, 23].

Porosity forms easily, because the examined solder paste normally contains 11.5 volume percentages of volatile components (e.g. flux) [21]. Flux vapour will be produced during reflow soldering due to thermal decomposition. Some gases may be entrapped between the flat surface of the printed circuit board (PCB) and the solder, and cause pore formation during solidification. The Fig. 5. shows the cross section of the solidified solder and pores.

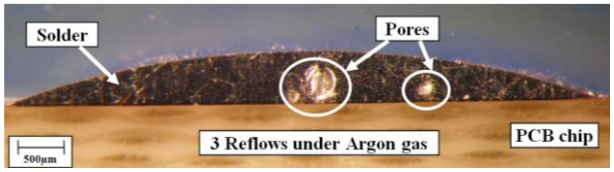

Figure 5. Pores in the cross section of solder

The surfaces of pores are smooth and usually bright, indicating that the porosities were formed mainly by entrapped gases [18].

The Fig. 6. shows the measured wetting angles of the solder pastes on PCB chips as a function of reflows by different measuring atmospheres.

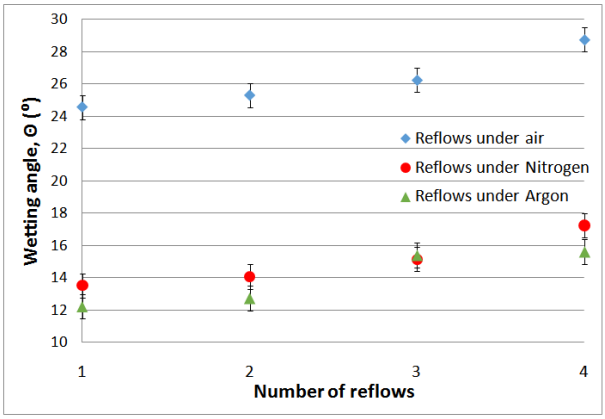

Figure 6. Wetting angle measurements of Sn 96.5 Ag 3 Cu 0.5 alloy on PBC substrates at 523 K

The effect of different atmosphere is easily definable. The measured wetting angles when using Argon or Nitrogen atmosphere are about 12˚-13˚. This value is in the well solderable range. On the contrary the wetting angles under air atmosphere are around 24˚. This value is double of the former results. It means that the solderability deteriorate when the solder was measured under air. The effect of increasing number of reflows increases the wetting angle values in all three measuring atmospheres. The wetting angles increased from 12˚ to 16˚ when Argon atmosphere was used, 13˚ to 17˚ when Nitrogen was used and increased from 24˚ to 28˚ when measured in air atmosphere. The increment of the wetting angle approximately 4˚ between the samples with 1 reflow and 4 reflows. The explanation of the difference between the wetting angle values is the different oxygen concentration. Well known, that the presence of oxygen deteriorates the wettability. That is why the values under air are higher than under Argon or Nitrogen. These differences indicate an increasing thickness of the tin oxide layer.

The same wettability measurements were performed on Cu plates as substrates. The wetting angle measurement results on PCB substrates show very similar effects in the case of Nitrogen and Argon atmosphere. Nitrogen is a more often used gas than Argon in soldering processes. The Cu plates and the solder paste were examined in Nitrogen and air atmosphere. The Fig. 7. shows the measured wetting angles of the solder pastes on Cu plates as a function of reflows by different measuring atmospheres.

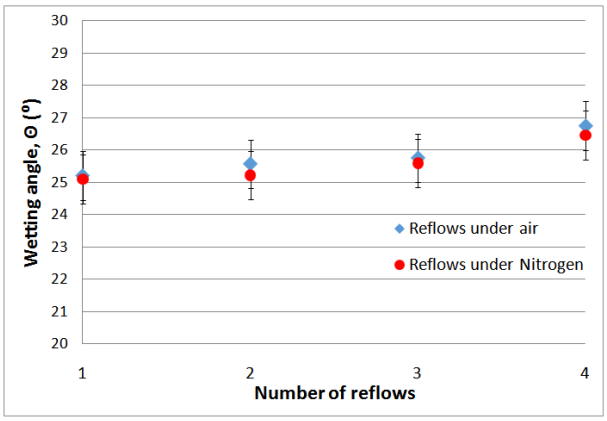

Figure 7. Wetting angle measurements of Sn 96.5 Ag 3 Cu 0.5 alloy on Cu substrates at 523 K

The measured wetting angles on Cu substrates show some similarities with the measured wetting angles on immersion tin coated PCB substrates. The wetting angles are rising with the number of reflows but on Cu the increment of the wetting angles are lower than in the case of tin coated PCB substrate. The wetting angles on Cu substrates do not show difference between the atmospheres. It means that the solderability do not get better when the solder was measured under inert (Ni) atmosphere.

To investigate the Cu/solder joints a microscopic cross-sectional study was necessary. A microscopic image of a PCB substrate with solder after the wettability measurement is shown in Fig. 8.

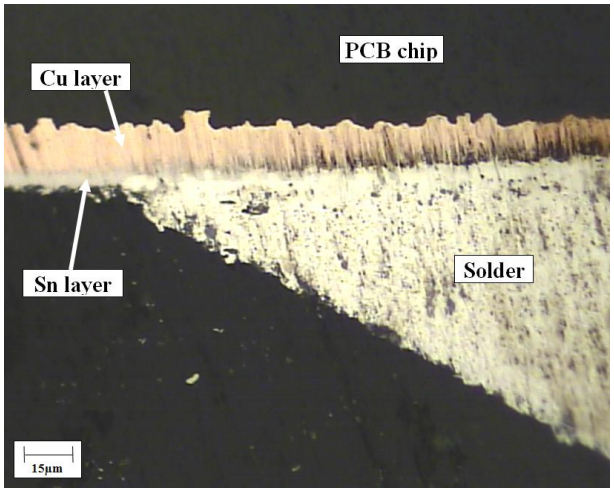

Figure 8. The investigated solder interface

During heating up, the molten solder reacted with the immersion tin and the Cu layer and formed different types of intermetallic compounds at the Cu-solder interfaces. The formation of intermetallic compounds between the molten solder and substrate is the case of reactive wetting. It is well known that the occurrence of the intermetallic compounds (IMCs) between solders and substrate metals is an indication of good metallurgical bonding. A thin, continuous and uniform IMC layer is an essential requirement for good bonding [24]. However, due to their inherent brittle nature and the tendency to generate structural defects, too thick IMC layer at the solder/conductor metal interface may degrade the reliability of the solder joints. For example, a small duration of peak temperature results in an incomplete wetting and cold joint formation. On the other hand, too high peak temperature or prolonged peak temperature duration may result in the formation of a brittle joint [24]. The investigated cross sections of the samples showed that the solder paste evenly melted and wetted good the whole PCB surface. There was a continuous and uniform transitional layer between the Cu and the solder indicating that the created bonding was good.

4. Conclusion

The reflow and atmosphere dependence of the wetting angle are measured on PCB and Cu substrates for Sn 96.5 Ag 3 Cu 0.5 (SAC305) melts. It was found, that the reflow dependence of the wetting angle is remarkable by increasing the reflow numbers. The wetting angles increasing approximately 4˚ in all three atmospheres on immersion tin coated PCB substrates. On Cu substrates the effect of reflows and the increment of wetting angles are lower. The different soldering atmospheres in case of Cu substrates do not show relevant differences on the measured wetting angles. On the contrary on PCB substrates in inert gas atmosphere (Ar, Ni) the wetting conditions provide an approximately 12˚ wetting angle better than at air atmosphere. On PCB substrates in inert gas atmosphere the flux of the Senju M705-GRN360-KV lead-free solder paste working better and spreading out more than in air atmosphere. Some gases may be entrapped between the flat surface of the substrate and solder paste, and may cause pore formation during solidification.

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ROLLER BURNISHING AND DEBURRING USING APPARATUS WITH PERMANENT MAGNET

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Abstract
In this paper, the authors present the results of experimental and developing work regarding Magnetic Assisted Roller Burnishing (MARB) process and apparatus using permanent magnet that operates by surface finishing, deburring and by the strain hardening effect. Additionally, the paper demonstrates the benefit of using the apparatus with permanent magnet against using the apparatus with electro magnet. Finite Element Method (FEM) modelling software system was used to demonstrate the experimental results.

Keywords:
Magnetism; Burnishing; Deburring; Strain hardening; Simulation; FEM

1. Introduction

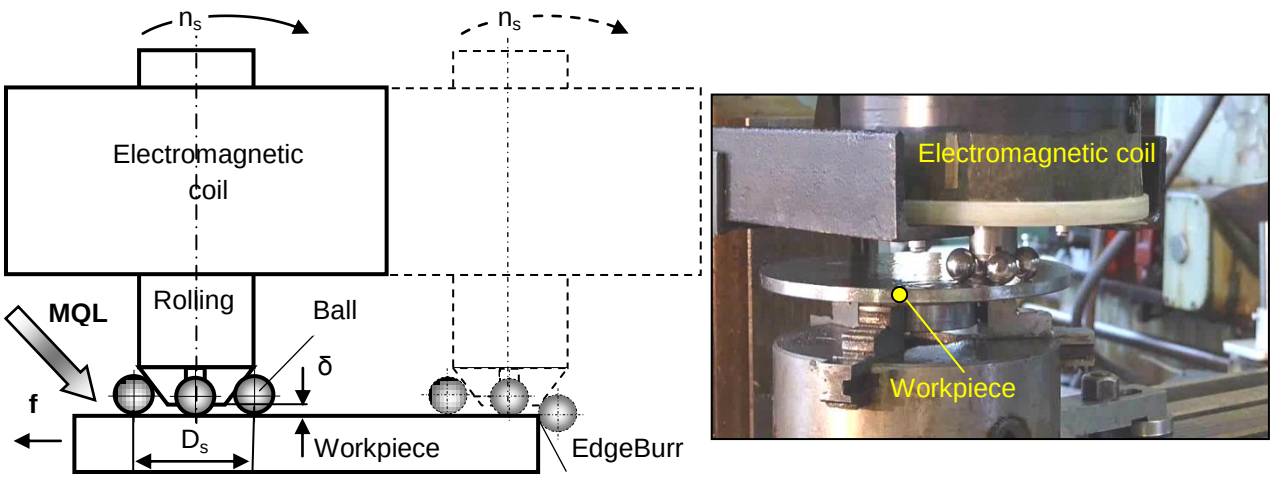
There are a lot of known solutions of mechanical roller-burnishing technologies [1,2,3,4]. In this paper, the results of a comprehensive research work, which was carried out regarding roller burnishing metal parts in magnetic field, will be presented. This recent fine finishing process is based on the following concept: the surface roughness of steel workpieces made of annealed steel or other ductile, magnetisable materials can be considerably decreased by burnishing in magnetic field using hardened steel balls, in addition, the hardness of the surface layer would remarkably increase and there is a possibility to eliminate fine burrs. The necessary pressure and relative speed between the tools and the workpiece are ensured by the magnetic force using apparatus with electro magnet or using apparatus permanent magnet.

2. Magnetic Assisted Roller Burnishing of flat surfaces with electro magnet

For the Magnetic Assisted Roller Burnishing of flat surfaces, a relatively simple experimental burnishing equipment was designed and adapted to a vertical milling machine. The concept is illustrated in Fig. 1a, while the experimental setup can be seen in Fig. 1b. During rolling, the hardened (HRC64) magnetisable balls were kept between the burnished surface and the conical end of the rotating arbor by magnetic force. In the course of the burnishing tests, ferromagnetic C45 type steels (HB = 150) and non-ferromagnetic Al-alloy workpiece materials were investigated [5,6,7,8]. The result was that the ferromagnetic steel was burnished with better results than the non-ferromagnetic Al-alloy material, because of higher magnetic force and continuous ball rotation, because each ball has a point of rotation where it comes into contact with the workpiece. By the machining, a Minimal Quantity Lubrication (MQL) System with 20 °E synthetic oil was used.
In the tests, the electrical parameters of the electromagnet were: charging voltage U = 40V, amperage I = 5...20 A (direct current, adjustable) generating B = 1,3…1,8 T magnetic induction in the δ ≈ 3 mm gap. The electromagnetic coil has 600 winds with Ø2 coil-wire and the measurement of the iron core is Ø25x100 mm.
By burnishing flat surfaces, the arrangement of the magnetic induction lines for ferromagnetic (steel) and non-ferromagnetic (Al-alloy) workpiece materials is illustrated in Fig. 2. For modelling the ANSYS 11.0., Workbench/Magnetostatic FEM software was used. In Fig., 2 it is clearly visible when rolling ferromagnetic materials, the point of ball rotation occurs by the magnetic adhesion, while in case of non-ferromagnetic materials it does not.

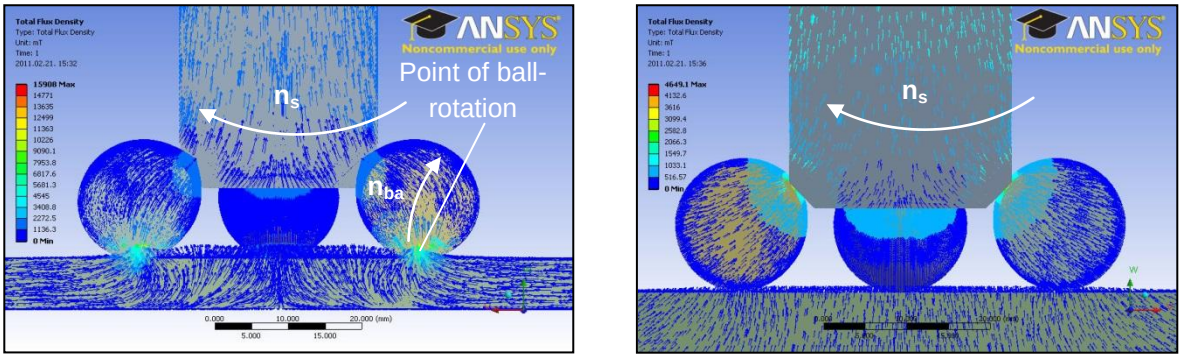
3. Magnetic Assisted Roller Burnishing of flat surfaces with permanent magnet

By the MARB with electro magnet, the process automation is a very big problem, for example the usability of the apparatus on the CNC machine. Therefore, a new MARB tool with permanent magnet was developed. Fig. 3 shows the tool-parts and the 3D image of the tool.
The new tool can be positioned in the tool holder and can be taken to working position according the machining process. Fig. 4 shows the tool after burnishing in the tool holder. The shiny surfaces of the workpiece are burnished surfaces.



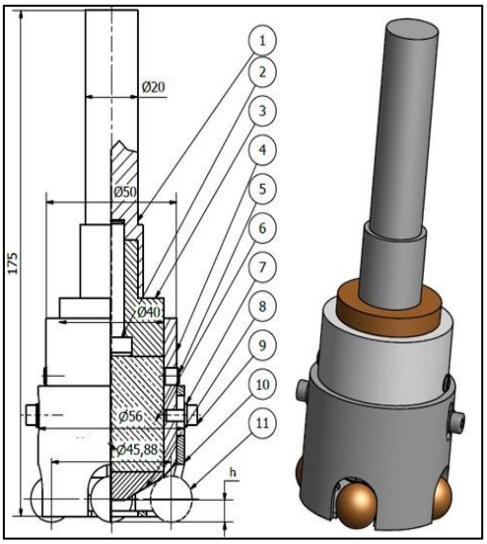
a) **b)**

Figure 1. Concept of Magnetic Assisted Roller Burnishing of flat surface (a) and the photo of the MARB equipment (b)



a) **b)**

Figure 2. Arrangement of magnetic induction lines for steel (a) and Al-alloy (b) workpiece materials when burnishing flat surfaces



1 Shank (NM); 2 Screw (M); 3 Bush (M); 4 Socket (NM); 5 Fixture screw 1 (NM); 6 Permanent magnet; 7 Underplate (NM); 8 Nose-piece (M); 9 Fixture screw 2 (NM); 10 Ball-cage (NM); 11 Steel ball (M)
Remark: Magnetizable (M), Non magnetizable(NM)

Figure 3. The MARB tool with permanent magnet

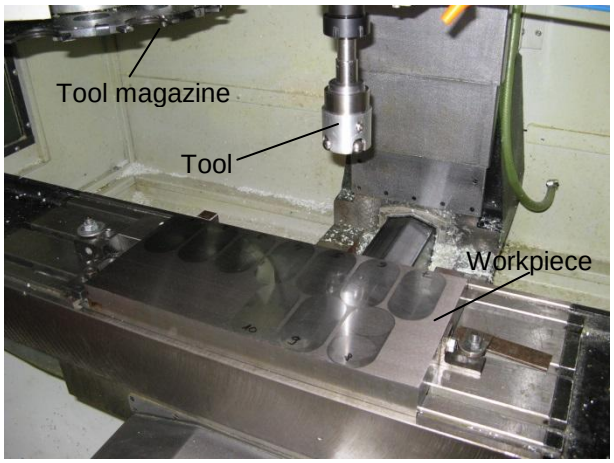


Figure 4. The MARB tool in the tool magazine after burnishing

4. Practice results of MARB

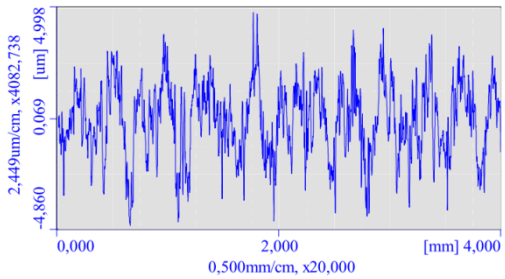
As it was mentioned, the surface roughness can be improved after the MARB, the burnished surface layer will harden and the burr can be removed from the side of burnished surface.
We present some of these practical results as follows.

4.1.The surface roughness after MARB process

We machined plate C45 in normalized conditions (HB 150) by CNC milling machine after grinding in two technological variants. The technological parameters of burnishing are in Table 1, the results are shown in Figure 5.
The ball diameter in both cases was p=16 mm, and the bearings were made from steel. By the machining, a Minimal Quantity Lubrication (MQL) System with 20 °E synthetic oil was used.

Table 1. Surface burnishing conditions at permanent magnet after grinding

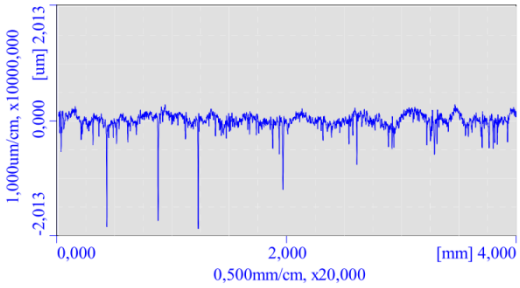
Technology		1	4
Tool revolution	n_s , rev/min	130	413
Tool diameter	D_s , mm	Ø 44,5	Ø 44,5
Burnishing speed	v_b , m/min	18,2	57,7
Feed speed	v_f , mm/min	18,235	62,87
Feed rate	f_g , mm/ball	0,035	0,038
Tool distance	h, mm	7	7



Paraméter tábla

	Profil=R_ISO - Szakasz=[1]	Átlagérték
Ra (um)	1,296	1,296
Rq (um)	1,596	1,596
Rz (um)	8,226	8,226
Rt (um)	9,389	9,389

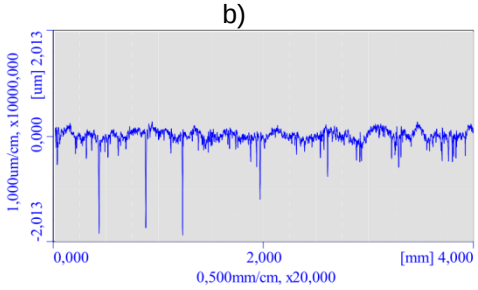
a)



Paraméter tábla

	Profil=R_ISO - Szakasz=[1]	Átlagérték
Ra (um)	0,078	0,078
Rq (um)	0,104	0,104
Rz (um)	0,757	0,757
Rt (um)	0,976	0,976

b)



Paraméter tábla

	Profil=R_ISO - Szakasz=[1]	Átlagérték
Ra (um)	0,112	0,112
Rq (um)	0,187	0,187
Rz (um)	1,857	1,857
Rt (um)	3,308	3,308

c)

Figure 5. The Surface roughness after grinding (a) and MARB (b, c)

On the Fig.6-7 we can see the evaluation of R_a and R_t before and after MARB.

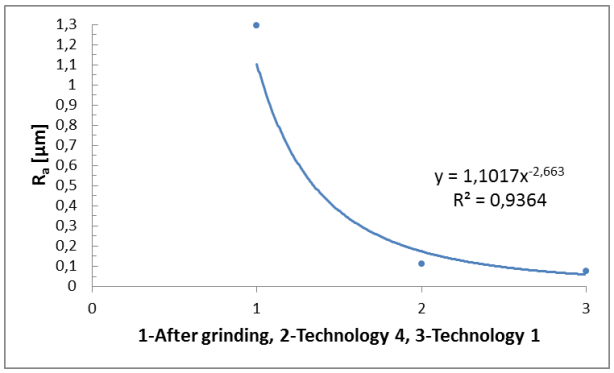


Figure 6. The surface roughness average (R_a) evaluation

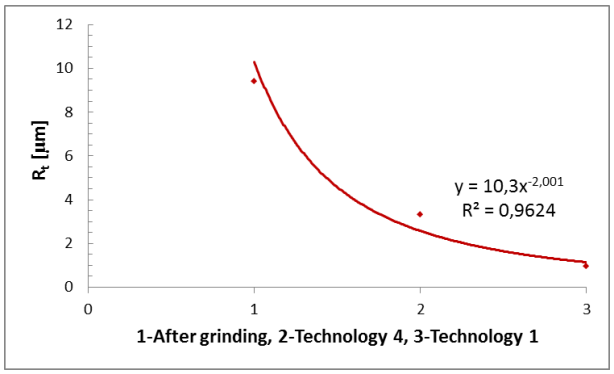


Figure 6. The surface roughness total height (R_t) evaluation

5. The hardening by MARB

Using MARB in one stroke, the hardness of the surface layer can increase one and a half times more at Δr = 20…30 µm thickness (Fig. 7). By the machining the ball diameter was D_g = 8mm; the forming speed: v_b = 40 m/min; the forming force: F_r = 90 N; the workpiece material: C45 annealed.

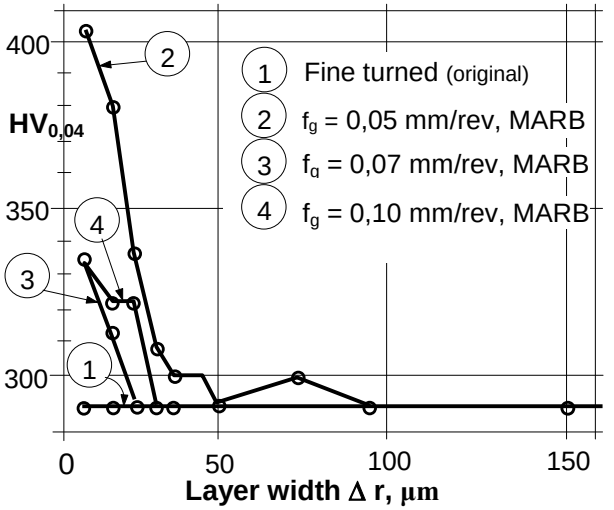
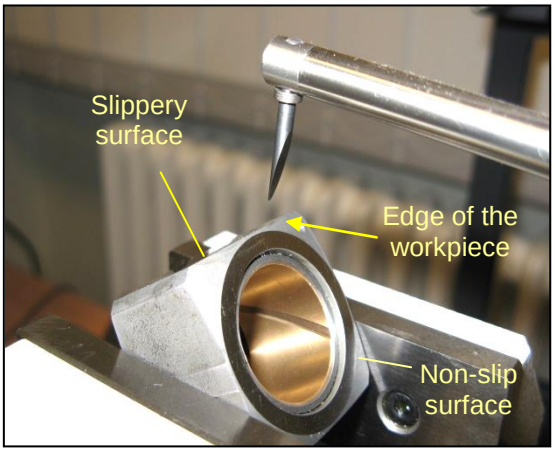
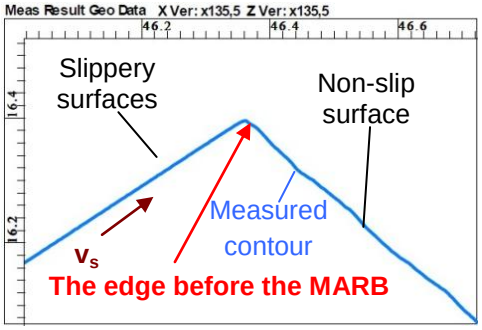


Figure 7. The hardening of surface layer after MARB

6. Deburring by MARB

The process is also suitable for eliminating fine burrs from the edges of flat surfaces, because the balls – in the case of ductile workpiece materials – may press the burrs into the workpiece-edge or the extra sharp edge to the other side of the workpiece (see Fig. 1a). The machining lights the sliding movements (v_s) of the slippery surfaces and impedes the possible jam in the guide way of metal parts (Fig. 8). Actually, this process is the magnetic version of the edge rolling operation of sheet stocks using pinch rolls to remove burrs or reroll the material into the edges [9] [10].





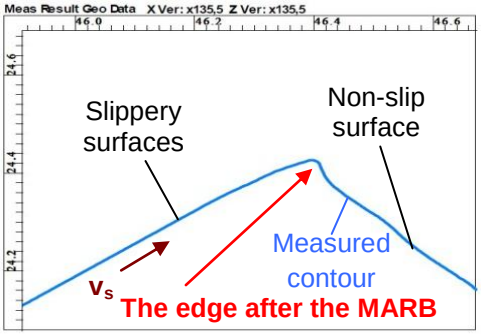


Figure 8. Measurement of the edge contour on the sliding block with MITUTOYO Formtracer SV-C3100 equipment

7. Conclusion

Experimental devices were constructed by the authors for performing to finish machining tests by Magnetic Assisted Roller Burnishing (MARB) process, using steel and Al-alloy specimens. During the tests, geometrical and kinematical

parameters of the surface quality were investigated and determined in detail.
The main results obtained in this experimental work are summarised as follows:
Based on the results of the experiments, it has been proved that this process can be effectively and economically used for finishing (burnishing) flat surfaces of magnetisable metal workpieces. The result depends on the technological conditions and the design of the tool.
In addition to the decrease of the surface roughness, the hardness of the surface layer may considerably increase within the depth of 10…30 μm due to the strain hardening.
In some cases, MARB technology gives opportunity for improving of sliding properties by burnishing of burrs or sharp edges.
MARB tool with newly developed permanent magnet allows the integration of technology into automated machining processes

Acknowledgement
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MACHINEBILITY OF THE NI-BASED SUPERALLOYS BY END MILLING

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Abstract
This paper describes the results of an R+D work on the field end milling of the Rene 108 and the GTD 111 Ni-based superalloy. In the investigation of machinability by end milling technology, the authors used force, torque and additionally temperature measuring equipments and methods. For the furtherance of the practical adaptation of the R+D results by the measuring process and data evaluation, advanced IT-properties were applied.

Keywords:
Machinability; Ni-based superalloy; End milling; Cutting force; Cutting torque; Cutting temperature

1. Introduction

Utilization of Ni-based superalloys is more widespread in industries of energetics, aerospace research. High strength, low thermal conductivity, heat and corrosion resistance, paramagnetism are common features of each alloy. Despite the fact that these materials are difficult to machine, parts made from them are machined often. On the bases of factory experience, milling of grooves causes the most problems. Slot cutters wear very intensively, break often and the productivity of them is very low. Authors tested slot milling options of alloys Rene 108 and GTD 111. In the first part of the experiments they performed theoretical comparative evaluation on the bases of available data, they sought to uncover the real facts of difficulties of material removal by slot milling experiments. After the evaluation of the measurement data, it was possible to compare the machinability indicators according to theoretical and practical aspects.

2. Chemical, mechanical and physical properties of materials RENE 108 and GTD 111

Alloy, used for the experiments was Ni-based superalloy Rene 108 (B50A936) and GTD 111 (B50A719), which was produced with special vacuum casting. Chemical composition of these materials is in Table 2.1. This table contains data of austenitic, corrosion resistant material KO36Ti (X6CrNiTi1811) and non-alloy carbon steel with sign C45 as reference materials [3], [4], [5].

Table 2.2 summarizes important mechanical properties from aspect of machinability, while Table 2.3 summarizes the physical properties [6].

Table 2.1. Chemical composition of Rene 108 and GTD 111 Ni-alloys as well as KO36Ti and C45 steels

Material	Rene 108	GTD 111	KO36Ti	C45
Fe%			68,8	98,9
Ni%	63,3	62,37	11	
C%	0,07	0,08	0,1	0,45
Si%			1	0,17
Mn%			0,5	0,5
Cr%	8	13,7	18	
Co%	9	9		
Al%	5,25	2,8		
Ti%	0,6	4,7	0,6	
W%	9,3	3,5		
Mo%	0,4	1,4		
Ta%	2,8	2,4		
Zr%	0,005			
B%	0,01	0,05		
Hf%	1,3			

Table 2.2. Mechanical properties of Rene 108 and GTD 111 Ni-alloys as well as KO36Ti and C45 steels

Material	Rene108	GTD 111	KO36Ti	C45
Tensile strength, MPa	1331	1310	490	610
Elongation A5,%	8	5	40	16
Contraction Z , %	10	5	55	40
Hardness HB, N/mm^2			180	230
Hardness HRC	42,1	41,4		

Table 2.3. Physical properties of Rene 108 and GTD 111 Ni-alloys as well as KO36Ti and C45 steels

Material	Specific weight ρ, kg/m^3	Thermal Conductivity 20C°-on λ, W/m°K	Specific Heat on 20 C° c, J/kg°K
Rene 108	8130	12,1	0,444 x 10^3
GTD 111	8000	12,56	0,452 x 10^3
KO36Ti	7800	12,5	0,502 x 10^3
C45	7700	45,35	0,461 x 10^3

3. Machinability of RENE 108 and GTD 111 superalloys

The machinability of metals influences the following properties: tissue structure, tensile, hardness, expansion and contraction, thermal conductivity and specific heat.

Tissue structure of Ni-based superalloys consists of the austenitic γ-phase, γ'-phase, primer metal carbide and secondary metal carbide.

The corrosion and thermal resistance, low thermal conductivity and paramagnetism is typical in the austenitic phase

High strength of Ni-base superalloys is due to γ'-phase and to metal carbides. The γ-phase is face-centred, has cubic crystal structure, where atoms of Ni, Ti and Al distribute in grids randomly.

Crystals of γ'-phase, appearing at secession are face-centred, cubic, but the location of the atoms is specified: the Ni-atoms are in the face-centre, Ti or Al atoms are located in the summit. Dislocations can cross with difficulty between two phases, this results in the increase of the strength of the alloy.

Chemical composition of alloys Rene 108 and GTD 111 has the potential for very hard primary (TiC, TaC, NdC) and secondary carbide (WC, $Cr_{23}C_6$, Mo_2C) formation. These carbides prevent the slippage along the grain boundaries in order to increase the strength of alloy further [7]. The machinability is strongly affected by the intensive abrasive action of carbides.

Based on the micro structural analysis, the wrong machinability is explained by the low thermal conductivity and low heat storage capacity. Also, the precipitated γ'-phase and the hard carbides can be explained by the impact of increasing solidity.

In terms of tensile strength, hardness and ductility, as long as we accept that the stronger material is more difficult to machine, the machinability order is following:

KO36Ti (σ_{EKO36} = 664 N/mm^2) ← C45 (σ_{EC45} = 670 N/mm^2) ← GTD 111 (σ_{EGTD11} = 1345 N/mm^2) ← Rene 108 ($\sigma_{ERENE108}$ = 1391 N/mm^2).

The ranking was based on the σ_E real limit voltage of uniform elongation, where also the material elongation (A_5) is taken into account:

$$\sigma_E = \frac{R_m}{1-\frac{0{,}52A_5}{1-0{,}52A_5}} \quad (1)$$

Two machinability index can be formed with thermal characteristics:

- thermal conductivity ratio

$$K_{hv} = \lambda/\rho, \quad (2)$$

heat absorption index

$$K_{he} = \lambda \cdot c. \quad (3)$$

Increasing of both indexes decreases the heat load of the tool. Table 3.1 contains the results.

Table 3.1.Qualified indicators on the basis of the thermal properties of the materials Rene 108, GTD 111, C45 and KO36Ti

Mat.	K_{hv} Wm^2/kg°K	Ratio %	K_{he} J^2/mkgs °K^2	Ratio %
Rene 108	0,00149	26	5,37 x 10^3	26
GTD 111	0,00157	27	5,68 x 10^3	27
KO36Ti	0,00160	28	6,27 x 10^3	30
C45	0,0058	100	20,91 x 10^3	100

The machinability order according to the table is the following:

C45 ← KO36Ti ← GTD111← Rene108, which - as is apparent from the upcoming results - is better than the previous order, but still does not perfectly reflect the reality.

The solution could be the introduction of the indicators: hybrid, thermal conductivity-strength

$$k_{hv} = K_{hv}/\sigma_E \quad (4)$$

and the heat-absorption-strength

$$k_{he} = K_{he}/\sigma_{E,} \quad (5)$$

Obtained values of the indicators and their ratios are shown in Table 3.2.

Table 3.2.Hybrid indicators of the Ni-base superalloys together with the reference materials

Material	k_{hv}	k_{he}	K_{hvC45} k_{hv}/k_{hvC45}%	K_{heC45} k_{he}/k_{heC45} %
Rene 108	1,07 x10^{-6}	3,86	12,5	12,3
GTD 111	1,167 x10^{-6}	4,22	13,5	13,5
KO36Ti	2,41 x10^{-6}	9,44	27,8	30,2
C45	8,66 x10^{-6}	31,21	100	100

From the table, it is apparent that at the machining of Ni-based superalloys (according to the sequence of the machinability) compared to C45, we expected 87…88% reduction of the productivity. Compared to the Ni-containing alloy steel, we could expect 52…56% reduction of productivity.
To sum up, Figure 3.1 presents the comparative percentages of hybrid machinability indicates.

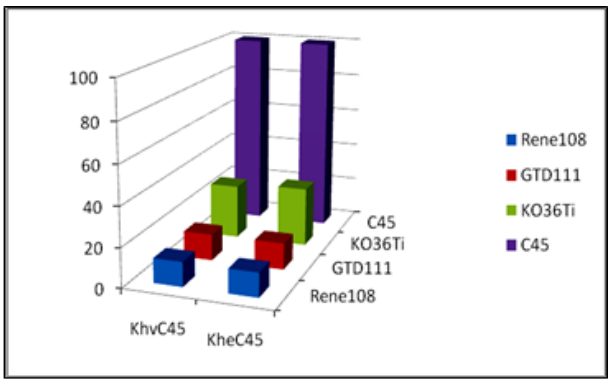

Figure 3.1.Machinability Up Sort based on hybrid indicators

4. Machining experiments

Machinability indicators, formed on the bases of the given data and their comparative analyses are like a rough guide. The real situation assessment is only possible with machining experiments. It is also true when the task is to machine Ni-based Rene 108 and GTD 111.

Condition of the experiments

Machine tool

The experiments were performed on the EML-8500 5AX type, 3D machining centre with vertical spindle.

Parameters of machine are following:
n_{smax} = 12 000 rev/min, P_{max} = 15 kW, M_{max} = 105 Nm, working area: 850x510x560 mm^3.
The machine bed and scaffolding are made from sturdy cast iron. Workpieces were fixed to manually operated machine vice, tools were taken to precision cartridge.

Tool

We selected the tool with best performance after several testing experiments, which was end mill cutter with variable groove with sign ProtomaxTMH4038217-8-1 from Company Walter.

Characteristics of tool are the following:
edges z = 4, diameter D = Ø8 mm, content of Co ≈ 12%, substrate material: fine-grained carbide, coat: reducing abrasion and friction, with composition TiAlN-ZrN.

Workpieces

Geometrical dimensions and strength properties of the used workpieces are summarized in Table 4.1.

Measuring tools

Measuring the torque, KISTLER 9125 A24A2 force and torque measuring system with DynoWare 2825A1-2 software were used. FLIR T360 infrared camera was used for measuring the temperature.

Lubrication

Experiments of cutting were carried out with toolless traditional lubricationThe applied lubrication liquid was: BLASOCUT 35 combination with 6 % oilconcentration. The dose was 15 l/min.

Technological data

Cloed slot was milled with the following technological parameters: v_c = 16 m/min; f_z = 0,013 mm/tooth; a_p = 7,5 mm, a_e = 8 mm. The cutting lenght was: L= 90 mm

The torque and the temperature were measured according to the order shown in Figure 4.1 and in Figure 4.2 during the experiment.

Table 4.1.Geometrical dimensions and tensile strength properties of workpieces

M a t e r i a l		**Rene108**	**GTD111**	**KO36Ti**	**C 4 5**
Pre-production		Molded	Molded	Rolled	Rolled
Dimension	**m m ^{3}**	250x135x33	250x135x33	245x45x20	100x100x40
Hardness	**HRV/HRC**	413,7/42,1	406,9/41,4		
	HB, N/mm^2			1 8 0	2 3 0
Tensile strength	**R_m, MPa**	1 3 3 1	1 3 1 0	4 9 0	6 1 0

***Results of* the experiments**

At first, we investigated the evolution of cutting torque at four materials listed above. Results are presented in Figure 4.3. As you can see, the torque starts at high results (at machining of Ni-based superalloys), increases intensively, the measured values vary widely that can be result of increased tool wear and intensive vibration. The highest values are at GTD 111, when it reaches the M_c = 10 Nm. Experience shows that tool breaks with chance of 90 %.It should be noted that the difference between reference materials is low because of the tool and technology used here. The tool wear is lower and the material removal stays without vibration.
We measured the temperature of chip with infra camera when it grooved without any cooling. In Figure 4.4, you can see the histogram made from the maximum values. Table 5.1 contains torques and temperatures measured in the experiments in absolute and percentage. The percental averages can be compared to the values of C45 in Table 4.2.

Figure 4.1.Work place with force and torque measuring system

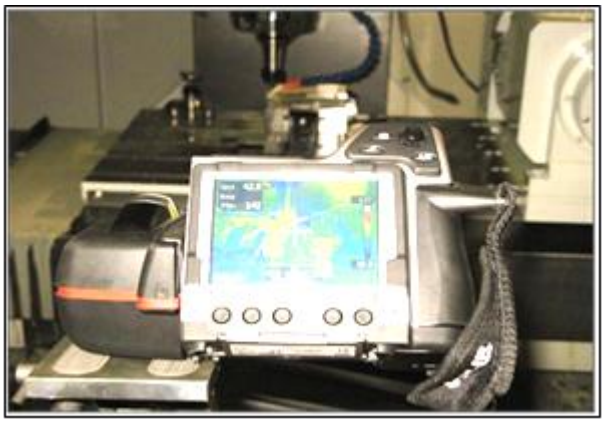

Figure 4.2.Work place with infrared camera

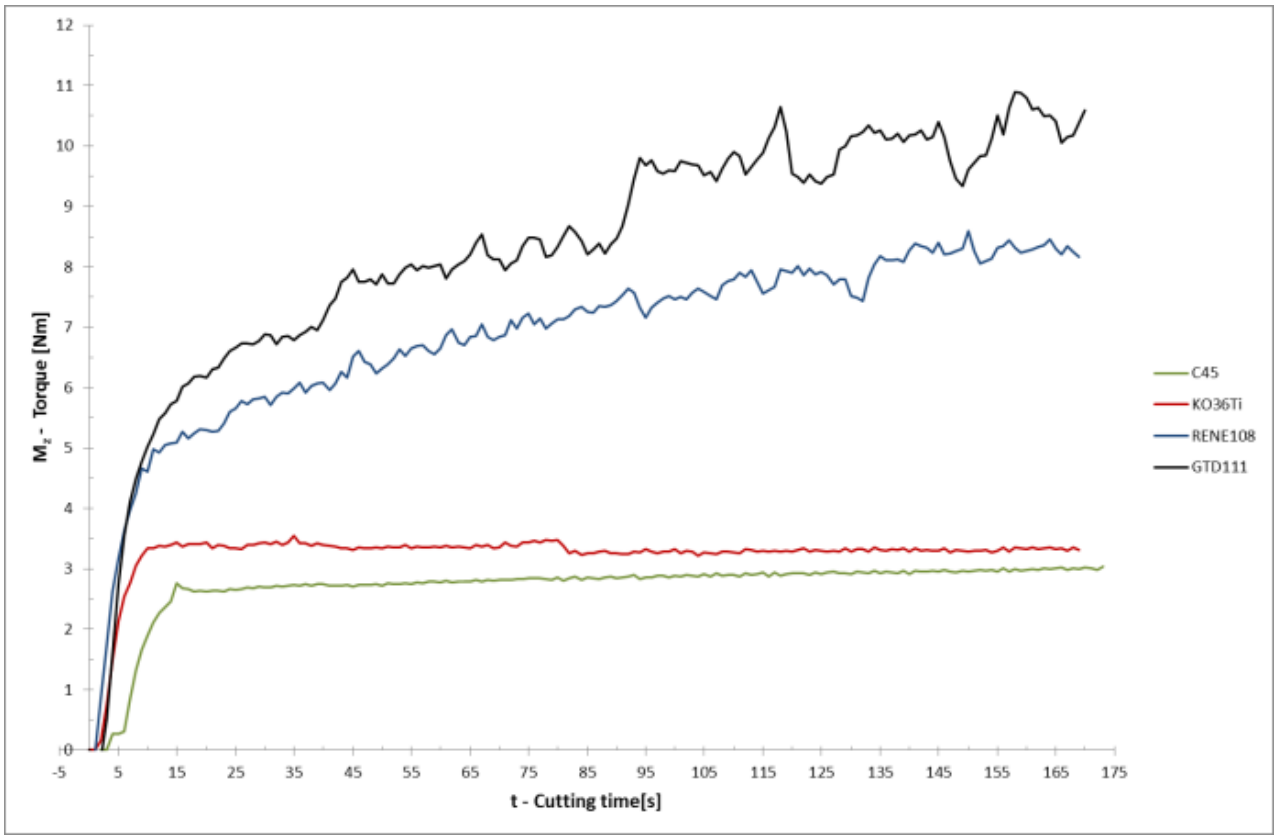

Figure 4.3.Evaluation of cutting torque at cutting length L = 90 mm

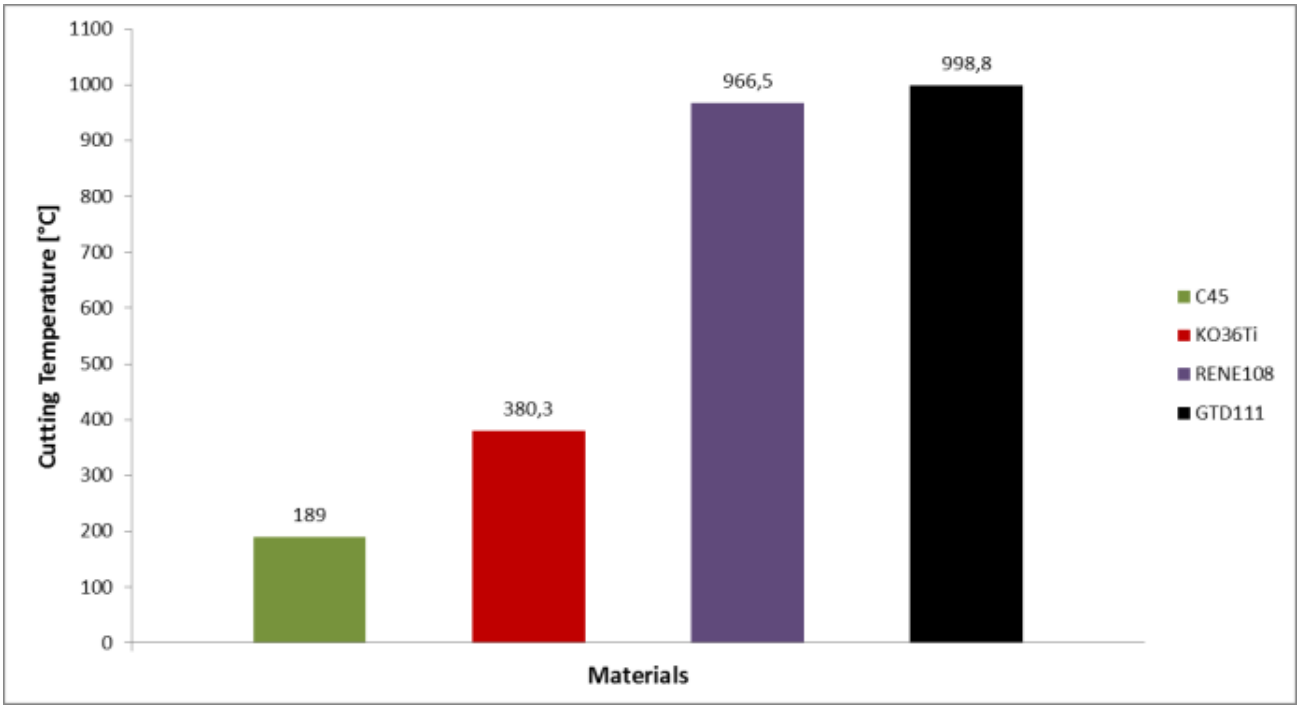

Figure 4.4.Evaluation of cutting temperature at Ni-alloys and reference materials used for tools after cutting length L = 90 mm

Table 4.2. .Machining indicators for C45, on the bases of the experiments

Material	GTD 111	Rene 108	KO36Ti	C45
Torque, Nm	10,8	8	3,2	2,6
Ratio,%	24	32	81	100
Cutting temp., °C	998	966	380	198
Ratio,%	19	20	50	100
Average,%	21	26	65	100

5. Conclusion

Sometimes happens that we categorize a material as well-machinable or with low machinability without having any actual knowledge about the technological conditions.

The formed opinion could be approximate only, but the so called „hybrid indicators", formed with the mechanical and thermal characteristics could be good reference points in the planning phase of the technology. The machinability indicators of Ni-based superalloys Rene 108 and GTD 111 suggests that expected machinability of these materials compared to C45 structural steel can be under 15%, compared to KO36Ti austenitic steel which is under 50%. The machinability of reference materials compared to each other is estimated on 50%, in favour ofóC45's.

After the performance of mechanical and thermal characteristics associated with torque and temperature experiments, we have received better results compared to previously indicated hybrid ratio. It has influenced the direction of safety at technological design. The difference is due to the end mill cutter with changing groove increase: ProtomaxTMH4038217-8-1 by Company Walter. The wear-resistant and anti-friction coat TiAlN-ZrN at tool geometry helped the material removal and improved the machinability.

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TOOL PATH OPTIMIZATION OF DRILLING SEQUENCE USING GENETIC ALGORITHM

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Abstract
This paper presents the approach of searching for the optimal tool path during drilling. The solution is obtained using the genetic algorithm where the drilling sequence optimization problem is reduced to the Travelling Salesman Problem. The genetic algorithm is used in order to minimize the path length, i.e. to reduce the total time of the tool path. The results achieved by the criterion of minimum tool path ultimately lead to savings of the technological time and decrease of the total cost of production. The solution of the problem was achieved using the MATLAB software, while the program code was designed for the selected technological task of drilling. The achieved software solution was simulated by the EMCO WinNC program for the Sinumerik 840D Mill control unit.

Keywords:
Optimization, Genetic Algorithm (GA), Drilling, Travelling Salesman Problem (TSP)

1. Introduction

Tool path planning, in this case in the process of drilling, is important for the production process because it leads to increase of productivity and production cost savings, especially if the tool that performs drilling operation must visit a significant number of places. Determination of drilling sequence is similar to the Travelling Salesman Problem based on finding the shortest path, where each city is visited only once and when it is known the distance between each city. Travelling Salesman Problem is one of the best known and most extensively studied combinatorial optimization problems and it is classified as NP (nondeterministic polynomial time) - hard problems. His mathematical model is searching for Hamilton's cycle at least weight in a weighted graph, and can be defined as a complete undirected graph G = (*V,E*) if it is symmetric, and directed graph G = (*V,A*) if it is asymmetric (edge weight, respectively, path lenght has different values depending on the direction of the tour). The set $V = \{1, \dots, n\}$ represents a set whose elements we call the vertex, $E = \{(i,j): i,j \in V, i < j\}$ represents a set whose elements we call edges, while $A = \{(i,j): i,j \in V, i \neq j\}$ represents a set whose elements we call arcs. Distance matrix $D = (d_{ij})$ satisfies ineguality triangle in case when is $d_{ij} \leq d_{ik} + d_{kj}$, for all i,j,k [1].

In the case of plane problems, $d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$ is the Euclidean distance.

The goal is to minimize the total path lenght d_{ij}

$$\min \sum_{(i,j)\in E} d_{ij} x_{ij}, \qquad (1)$$

within the constraints:

$$\sum_{j\in V:(i,j)\in E} x_{ij} + \sum_{j\in V:(j,i)\in E} x_{ji} = 2, \qquad i \in V \qquad (2)$$

$$\sum_{(i,j)\in E:\{i,j\}\in S} x_{ij} \leq |S| - 1, \forall S \subset V: 2 \leq |S| \leq n - 2 \quad (3)$$

$$x_{ij} \in \{0,1\}, \quad i,j \in V.$$

Expression (2) ensures that each city has visited only once, and according to the second limitations, expression (3), are not allowed subtours, i.e., eliminates the possibility that in the solution appears more than one contour.

A binary representation of solutions is not suitable for this type of problem, and the solutions are represented vectorial or matrix. Types of the vectorial representation are Adjacency Representation, Ordinal Representation, and representation in order of the tour which was used in this work. Each tour is possible permutation of 1,2,3,…,*n* where *n is* number of cities (in this case the number of holes), and the number of possible tours is *n!,* i.e., *(n-1)!* for assymetric problems, or *(n-1)!*/2 for symmetric problems when the starting point of departure of the tour are known. The case in this paper is *n!*/2 because it is a symmetrical problem and starting point of drilling isn't defined.

2. Optimization methods

Today, we have developed many methods to solve the Travelling Salesman Problem, which can be devided into [2]:

Exact methods – find an optimal solution, but because of its large computational complexity are limited to minor problems and their largest disadvantage is the long runtime.

Brute Force algorithm searches all possible permutations and remembers the best combination

to allways provide an optimal final solution, however, because of its $O(n!)$ complexity is the impractical even for the 10 cities.
Linear programming is the optimization method of the linear objective function, which is subject to constrains of linear equalities and inequalities. Branch and Bound is the general algorithm for searching the optimal solutions of many optimization problems. It consist of counting all the potential solutions, where large subsets of inferior solutions were rejected.
There are used method of dynamic search, Backtracking method, and Branch & Cut method.
Approximation methods – use the algorithms that provides so-called sub-optimal solutions in a relatively short time. The best known approximation algorithm is the Christofides' algorithm.
Heuristics methods – the methods for solving problems based on experience.
Solving the Travelling Salesman Problem with the algorithm of nearest neighbor starts searching from arbitrary initial city, and every next city is the one which is nearest to the current city without being visited yet. This algorithm usually does not provide an optimal solution, because it doesn't use all of the available data, for example, some of the city are visited too early which prevents later to finding a better solution, respectively, the solution converges to a local minimum. The adventage of this algorithm is in its implementation speed with a good optimum approximation, and it is used to compare and testing the other algorithms.
Except the mentioned, there is used the Greedy algorithm, Heuristic of nearest and farthest insertion, and Nearest insertion of arbitrary city.
Metaheuristics methods – are iterative procedure of solving combinatorial optimization problems that may include traditional heuristics such as one step of the procedure (e.g. local search). The essential characteristic of metaheuristics is to use the strategy of finding the global optimum. Sometimes metaheuristics allows the acceptance of inferior solutions of objective function in order to achieve the escape from a local optimum.
The best known examples are simulated annealing, genetic algorithms, and ant colonies optimization methods.
Solving the Travelling Salesman Problem with evolutionary algorithms is very common. Although evolutionary algorithms do not allways find an optimal solution, their advantage is that they can in real time find a solution that is very close to the optimal. Solving the problem of drilling sequence was obtained also by using GA.

3. Genetic algorithm (GA) – general model

GA is the optimization method based on the natural evolution, with the basic idea of survival of the best individuals in the population. Unlike most of the deterministic algorithms, GA does not start search from the one point of solution, already from a hole range of potential solutions that are usually randomlly generated and represents the inital population of the genetic algorithm. Depending on the given problem, capability (goodness) defined in fitness (objective) function, are determinate to the initial population. In every generation choosen solution is closer to the optimum in comparison with other members of the population, while inferior solutions were rejected. Selected solutions are subjected to genetic crossover and mutation operators in order to create a new generation. The procedure is performed iteratively until the stopping criterion is met as a defined by the user. The basic algorithm structure is shown in Figure 1.

Generate initial population **P(t)**
Evaluate population **P(t)**
While stopping criteria not satisfied **Repeat**
Select some elements from **P(t)** to copy into **P(t+1)**
Crossover of some elements of **P(t)** and put into **P(t+1)**
Mutation of some elements of **P(t)** and put into **P(t+1)**
Evaluate new population **P(t+1)**
P(t)= **P(t+1)**

Figure 1. Standard genetic algorithm [3]

The basic terms used in the work of genetic algorithm [4] are shown in the Figure 2.

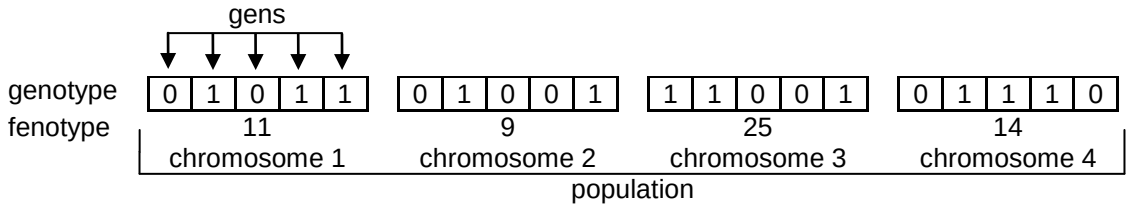

Figure 2. Display of the basic terms int the work of the GA

The chromosome consist of the genes, where each gen is an one parameter, or variable x_i = (i = *1,…,n)*.
X = [chromosome] = [gen_1,…,gen_n] = [x_1,…,x_n].

Each chromosome represents the one individual, or a one possible solution of the problem, and the set of all chromosomes makes the population, i.e., the set of all possible solutions. The genetic

algorithm process consist of the next steps: encoding of individuals, evaluation of fitness of individual, selection, crossover, mutation and solution decoding.

Encoding

The choise of solutions representation has a great importance because it can significantly affect at the efficiency of genetic algorithm, and usually is represented by string of bits and binary numbers.

Evaluation

Based on the defined chromosome (individual) randomly formed initial population, i.e., pre-selected sufficiently large number of satisfactory solutions to the problems, and for the each solution determines the value of the fitness function [5].

Reproduction (selection)

By the selection (Figure 3), good individuals are chosen and it will participate in reproduction, while inferior individuals were rejected. Selection involves the storage and transfer of good characteristics (genes) to the next generations of individuals [4]. Several methods of selection are developed and some of them will bementioned:

- Proportional selection in which individuals with the greatest ability (goodness) have the best chanse of being selected, and
- Tournament selection in which randomly, from the entire population, selects a certain number of individuals, from which choose the best for the next generation, and the process is repeated untill the number of offsprings reaches the population size.

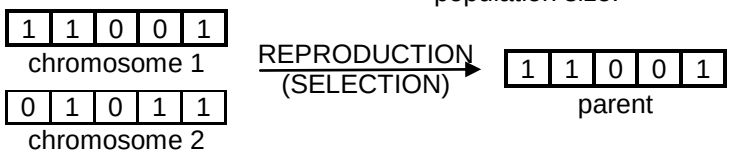

Figure 3. Selection in GA procedure

Crossover

Genetic crossover operator provides the change of the genetic material between individuals (chromosomes). After couples of parents were selected from population, because of selection process, and with crossing method from them offsprings that inherit properties from parent are created. There are many ways of crossing performance, and they are usually performed at a single point (Figure 4) or two crossing point (Figure 5), whereby the point of crossing randomly chosen. Traditional crossing operation is not applicable in the case of tool path optimization, because of requires that each gene in the chromosome may occure only once, and the ordinal sequence was used [5].

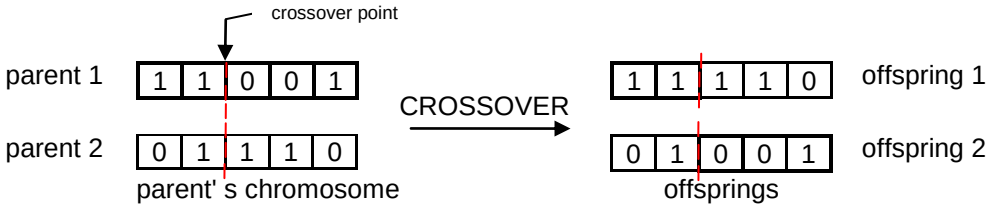

Figure 4. Crossover in one (single) point

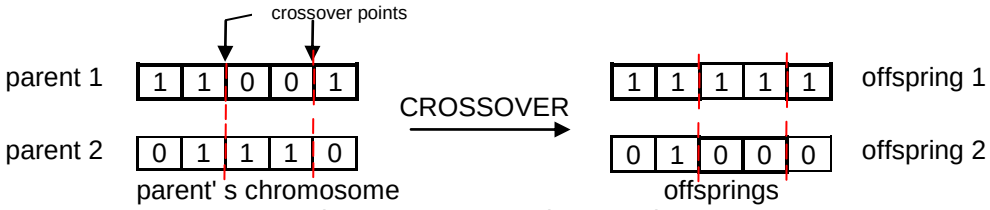

Figure 5. Crossover in two points

Mutation

Mutation is a genetic operator by which the space of solutions are searched and exactly mutation greatly helps to avoid local optima of the fitness function which we optimize. Applying of mutation the diversity of genetic material is achieved and searching for new – potentially best solutions are enabled (e.g. in the case that all the individuals of the population have the same gene in a specific location in the chromosome, only the crossing could not change this gene).

Although the selection and crossover generates the new strings, they do not introduce a new information in the population on the bit level. Therefore, a mutation is introduce, which brings the new aspekts in the population, that can arise the new search directions, thereby creating the conditions to prevent retention of local extremes. Mutation (Figure 6) at the level of genotype, randomly entries a new genetic material in the chromosomes or individuals [4].

There are different types of mutations, which among the other things, depends of the representation of chromosomes. In this paper, it is not possible to apply the traditional mutation operator, and it was used the permutation in which are two randomly selected genes swich the values (Figure 7).

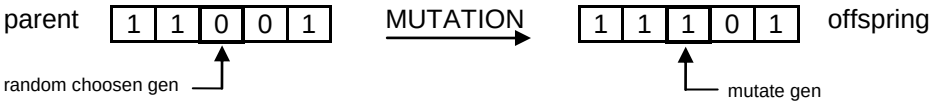

Figure 6. Mutation

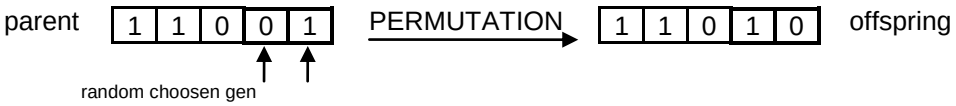

Figure 7. Permutation

Decoding

Decoding is the process of converting a binary number to a potential solution.

Elitism

The protection of the best individual of the possible changes or elimination, applying of genetic operators during the evolutionary process (selection, crossover or mutation) is called elitism. However, although elitism can improve performance of genetic algorithm, the protection of the best individual of each step of evolution can significantly slow down the genetic algorithm.

Genetic algorithm parameters

The tipically algorithm parameters are population size, number of generations (iterations), the crossover and mutation probability. Considering the values of the genetic algorithm parameters, the algorithm gives different results, faster or slower coming to a better or inferior solutions.

The population size is parameter that directly affects to the quality of the obtained solutions by reducing the probability of permature convergence to a local optimum, while the negative side of increasing complexity of computing and thus the total running time of the algorithm. Smaller populations provides a better solution for a small number of generations, and increasing of the population is necessary to increase the number of generations.

Number of generations is a parameter that directly affects at the algorithm execution time, as well as the quality of the obtained solutions. A larger number of generations gives a better solution, but with increasing the runing time, it is necessary to determine a number of generations by which the algorithm will find a satisfactory solution that may not allways be optimal to be satisfying.

A very important role in the work of GA has a parameter of mutation probability that allows avoiding of “stacking“ in the local optimum at random algorithm leaps per solutions spase.

A significant increase of the crossover probability reduces preservation of existing solutions, i.e., increases the degree of destruction of individuals with greater capability.

Termination of the algorithm

The process of creating the new generations is repeated until a predefined stopping criterion of evolution is not satisfied. Some of the stopping criteria for the algorithm are reaching predefined number of generations, satisfying the minimum criteria or the ending of evolutionary process, which is reflected in the way that successive repetitions do not lead to better results.

3. Experimental part

For the selected technological task shown in Figure 8 on the principle of Travelling Salesman, by using genetic algorithm, sequence of drilling was optimized. The task was defined drilling of 25 holes on the prismatic workpiece, with minimal tool path, where the starting point of drilling depends on the random selection of the genetic algorithm, and after the last hole drilling the tool is necessary return to the starting position. For a given problem of the tool path optimization, minimizing the lenght of tool path was realized using the MATLAB software and the achieved software solution was simulated in EMCO WinNC program for Sinumerik 840D Mill control unit.

The algorithm was run multiple times (50 times) with different combinations of population size and stopping conditions, in the aim of experimental determination of the number of individuals in the population and the number of generations of genetic algorithm (for the tool path optimization problem) an in order to determine parameters of the algorithm that gives the best solution. Initial population of chromosomes was randomly created, where each chrormosome represents a string of holes that need to drill, and each gene represents assigned number of holes.

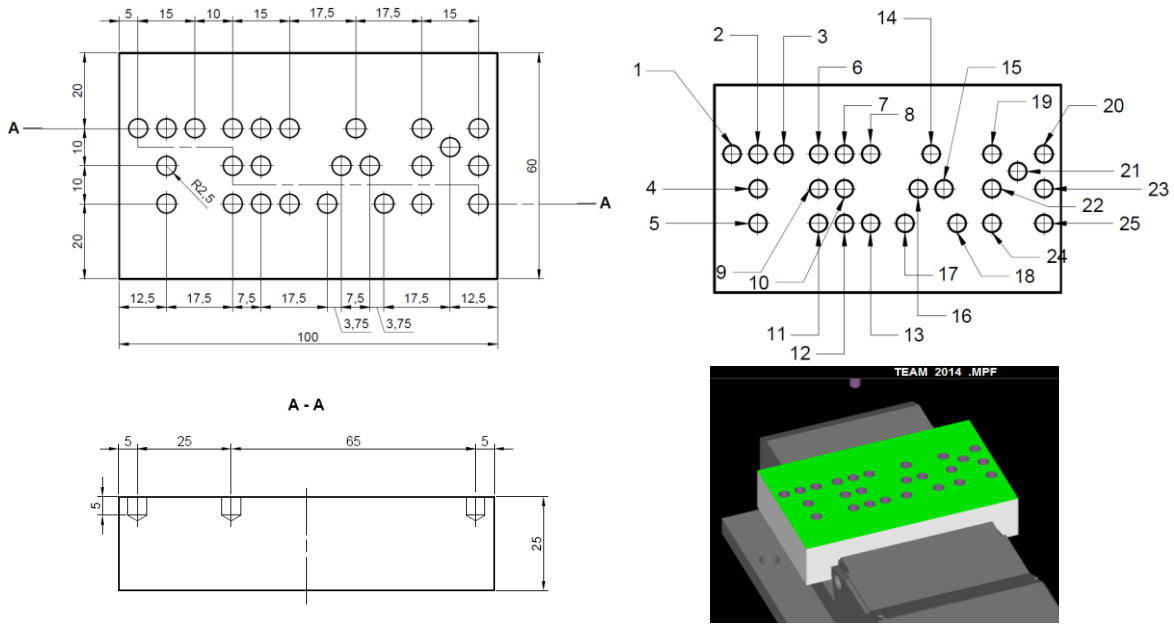

Figure 8. Prismatic workpiece for drilling

According to the Figure 9, there was obtained a total distance of tool path in the amount of 318,77 mm with manual programming, while the proposed genetic algorithm according to the size of the population and the number of generations (which causes stopping execution of the algorithm), finding the optimal solution almost in the all the combinations, i.e., the minimal distance of tool path in the amount of 263,86 mm.

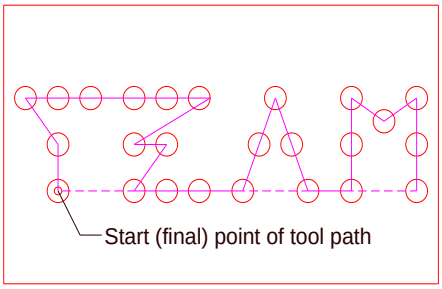

Figure 9. The total distance of tool path during the manual programming

The algorithm was tested on a sample with a small number of holes, and the results were compared with results obtained by heuristics nearest neighbour method. A Genetic algorithm, for the defined problem with 4 holes, finds an optimal solution already for the 10 generations and 5 individuals in the population.

Table 1 shows the average values obtained for all 50 times starting of genetic algorithm, from which it can be concluded that the genetic algorithm gives quite stable solutions very close to the minimum.

Analyzed the data (Table 1) concluded that a substantial increase the number of generations and number of individuals do not give much better solutions than the case with a smaller number of generations and smaller number of individuals. For a large number of individuals in the population during performance of the algorithm there is the possibility to appearance of a large number of similar or identical individuals that provide good solutions. By choosing these individuals for reproduction, diversity of genetic material are reduces and in that way are often obtained the lower results for the same number of generations with a plurality of individuals in relation to a smaller number of individuals for the same number of generations. For random generating a first population, the probability of appearance a good individual is higher when the population are larger.

Table 1. The average value of the fitness function in multiple algorithm startup

Number of generations	Number of individuals in the population				
	50	100	300	500	1000
100	292,7529	279,3912	269,0384	268,808	267,3062
300	270,5388	269,6934	267,3176	265,7477	264,4715
500	271,4110	270,0652	265,7013	265,6332	264,1243
1000	268,8153	266,8541	265,1995	264,6979	263,9364

Table 2 shows the average runtime of the algorithm in seconds, depending on the number of generations and population size. Smaller population have a higher chanse to “stuck“ in a local optimum, but through the generations iterates much faster than the larger population, which is more suitable for the complex problems, in this case for the problem with a large number of holes.

The program is performed on a laptop Acer Aspire 5741G, 2.2GHz, 3 GB of RAM.

Table 2. The average time of genetic algorithm performing

Number of generations	Number of individuals in the population				
	50	100	300	500	1000
100	1,7599	1,7614	2,0619	2,4213	3,2463
300	4,5814	4,7976	5,8271	6,9453	9,6913
500	7,9394	8,5237	10,3454	12,2061	16,4584
1000	16,7594	17,6131	21,1964	24,7049	33,5717

To solve the problem of minimizing tool path and to achieve the optimal solution for the proposed genetic algorithm, it was enough 100 generations and 100 individuals in the population.
Considering that genetic algorithm is multiple started, which generates a new solution, some of the obtained results have the same distance but with another drill path. In Figure 10 is shown a graphical representation one of possible solutions. From Figure 11 it is evident that the value of fitness function gradually decreases through the generations which is an indicator of optimization unfolding. In addition to reduce the value of the fitness function for the best individuals, also is reduced the mean (average) value of the fitness function of the population.

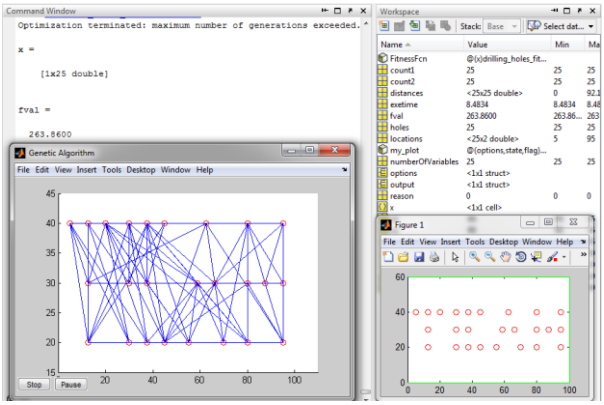

Figure 10. Graphical display of an optimal tool path

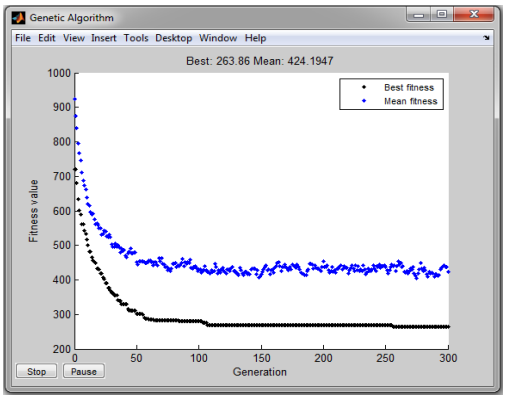

Figure 11. Fitness function depending on the number of generations

5. Conclusion

The paper tried to find the sequence of drilling operation that provides the shortest path, i.e., reduction of the total work time and efficiency increase with the assistance of genetic algorithm. Selection of the genetic operators and parameters which determine behaviour of these operators is an important for the successful algorithm work. The algorithm in relatively short time finds the optimal solution and therefore is reliable to use. In order to improve finding solutions, genetic algorithm is possible to combine with one of the methods for searching of local optimum, which leads to faster convergence of certain individual according to their optimum, which is potentially the global. This paper aims to reduce the total path, without considering tool wear, and the problem is solved for drilling holes of the same diametar and depth and the further research could expand in that sense. In further research the defined problem could be resolved with another metaheuristic optimization method (e.g. Particle Swarm Optimization or Ant Colony Optimization), with the possibility of comparing the obtained solution with the solution achieved with CAM software.

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DETERMINATION OF THE CRITICAL POSITION DURING THE ASSEMBLY OF THE BOILER HEAT EXCHANGER PACKAGE DUE TO THE STRESSES OF THE AUXILIARY FRAME STRUCTURE

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Abstract
Construction of the Thermal power plant boiler is usually large in size and weight. The aim of the production is to deliver the boiler assemblies on the construction site with maximal dimensions. This depends on the possibilities of transport and assembly. For such large and sensitive parts of the boiler structure it is necessary to carefully plan the mode of transportation and assembly. Very often it is necessary to create auxiliary structures which will stiffen the boiler component, so that it prevents damage and permanent deformation during the lift and assembly. In this paper will be analyzed strength of the auxiliary frame structure for lifting and rotating transport unit of the boiler heat exchanger package Tampere, during the rotation. Assembly unit is rotated from horizontal to vertical position. Rotation leads to changes in the amount and direction of load of the auxiliary frame structure. Aim will be to determine the critical position of the assembly unit, in which will occur maximal stress on the auxiliary framework structure. Stress calculations of the auxiliary frame structure will be made using the finite element method and beam finite element. Five different positions of the assembly unit will be analyzed; 0 °, 30°, 45°, 60° and 90°.

Keywords:
boiler heat exchanger assembly, auxiliary structure, critical position, finite element analysis

1. Introduction

There are many way in which can be transported and montaged parts as boiler heat exchanger assembly with its transport auxiliary structure. It is necessary to point out the need for more than one crane when doing complex procedure as it is rotation of the auxiliary structure with boiler heat exchanger assembly. Cranes for montage of the boiler heat exchanger assembly are used briefly on the construction site, so better to consider only mobile cranes. During the selection of the mobile crane it is important to have in mind reliability of devices, rated capacity limiters, motion limiting devices, working radius indicator, load indicators, etc. Every crane has its own load chart in which is clearly written lifting capacity of a crane. The lifting capacity of a crane is limited by its structural strength when the working radius is small and stability when the working radius is greater. The need to subtract the mass of the hook block and lifting slings from the capacity of the crane at the particular radius, unless otherwise noted on the load chart. For example, if the load chart states the crane can lift 20 tons at a given radius, but the hook and lifting gear have a combined mass of one ton, the load to be lifted cannot be greater than 19 tons. The crane counterweight is critical in ensuring crane stability. A counterweight that is too light for a load and boom configuration will cause the crane to overturn in the direction of the suspended load. On the majority of smaller mobile cranes, the counterweight is fixed and cannot be easily removed. However, on an increasing number of larger cranes, some of the counterweights are designed to be removed for road travel, or when smaller boom and lifting configurations are required. In this situation, it is particularly important to attach the correct type and number of counterweights to the crane for the particular lift to be undertaken. Many other notes on necessary conditions for proper use and selection of the cranes can be found in the literature [1]. Depending on the terrain on which montage is done, on the bearing capacity of the crane and the height which needs to be reached there is many different cranes from which can be chose for example: Telescopic Truck cranes with lifting capacities of 35 to 220 metric tons and working radius of 40 to 88 m, All Terrain cranes with lifting capacities of 30 to 1,200 metric tons and maximal main boom length of 30 to 100 m, Rough Terrain cranes with lifting capacities of 25 to 120 metric tons with maximal boom length of 30 to 50 m, there are several more of them which have higher capacities available and higher working radius such as Lattice Boom Crawler Cranes and Tower Cranes [2, 3]. During the montage it is not only necessary for the crane to endure the weight

of the boiler heat exchanger assembly and its auxiliary structure but that auxiliary structure endures under the applied mass of the boiler heat exchanger assembly. Mass of the boiler heat exchanger assembly and its auxiliary structure is taken from the Technical report for Tampere project [4]. For the insurance that auxiliary structure will not brake during the montage it is necessary to calculate with safety factors for steel construction [5]. Safety factors used in the Technical report for Tampere are for dynamical load 1,5 and for static load 1,35. During the montage auxiliary frame with boiler heat exchanger assembly is rotating from horizontal position to vertical position. In this paper finite element analysis is done for angular positions of the auxiliary structure of 0°, 30°, 45°, 60° and 90°.

2. Method

I this paper it is used beam finite element to get the proper results of the stress, displacement, internal forces and momentums distributed in the auxiliary structure. In the finite element analysis beam finite elements [6] are used for numerical analysis. Finite element analysis is made in the software ANSYS [7] where wireframe numerical model of frame with keypoints locations with characteristic profiles of cross sections is made. Beam used in the analysis with ANSYS is linear finite strain beam marked as BEAM188. Figure 1 shows the whole wireframe model of transport frame with plotted characteristic profiles on particular beams.

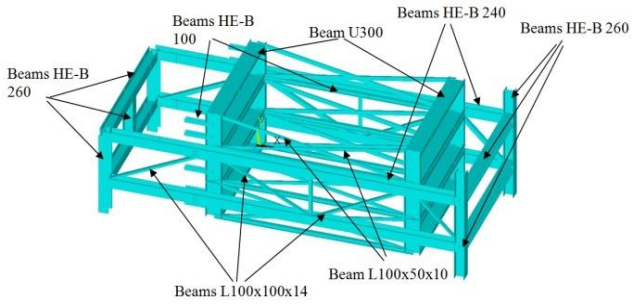

Figure 1. Characteristic profiles of an auxiliary structure

Material used for auxiliary frame is S235JRG2 [8]. Modulus of elasticity, yield stress, and allowed stress for beam material are:

$$E = 200000 \text{ MPa} \rightarrow t_c = 20 \text{ °C}, \quad (1)$$

$$R_e = 225 \text{ MPa} \rightarrow \text{for } \delta = 16 \div 40 \text{ mm}. \quad (2)$$

$$\text{Allowed stress: } \sigma_{\text{all}} = \frac{R_e}{1{,}1} = 204{,}5 \text{ MPa}. \quad (3)$$

Geometrical characteristics of cross sections are determined for particular profiles. It this paper used profiles are U300 [9], HE-B100, HE-B240, HE-B260 [10], L100x50x10 and L100x100x14 [11]. Example of profile characteristics used in ANSYS are shown in figure 2, 3 and 4. Auxiliary structure is loaded with boiler heat exchanger assembly which is shape as a harp, outline dimensions of the boiler heat exchanger assembly and auxiliary frame used for transportation which are used in the Technical report for Tampere are given in figures 5 and 6.

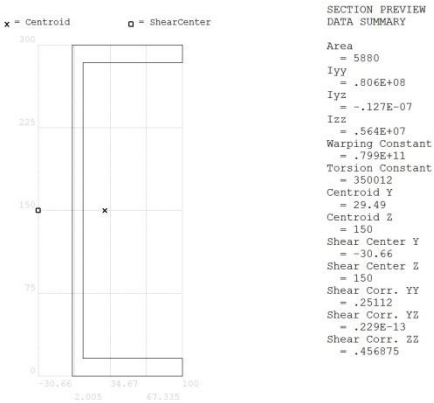

Figure 2. Profile characteristics of an U300

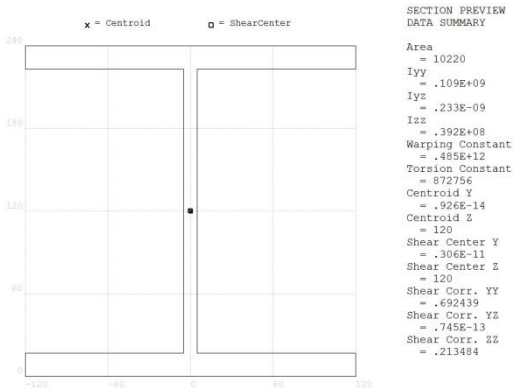

Figure 3. Profile characteristics of an HE-B240

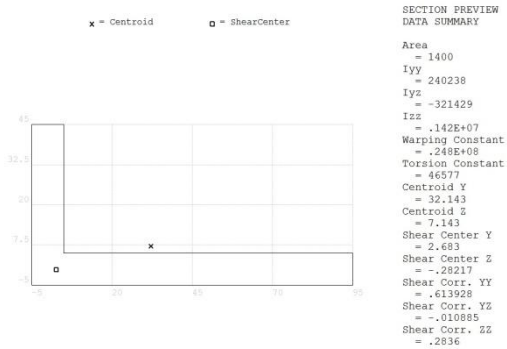

Figure 4. Profile characteristics of an L100x50x10

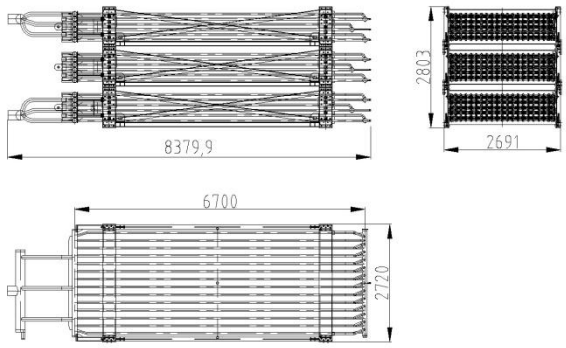

Figure 5. Boiler heat exchanger assembly's partial modulus with frame for rotation and lifting during erection

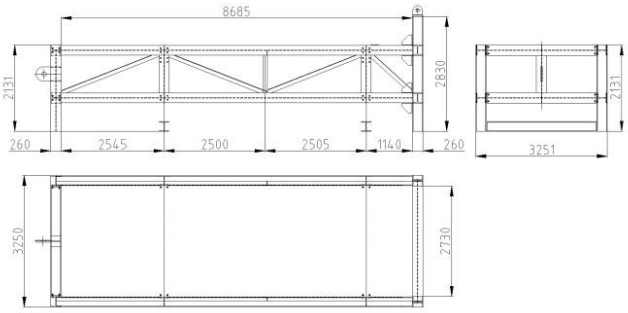

Figure 6. Auxiliary structure for rotation and lifting during erection

Finale vertical position after the montage is shown in figure 7.

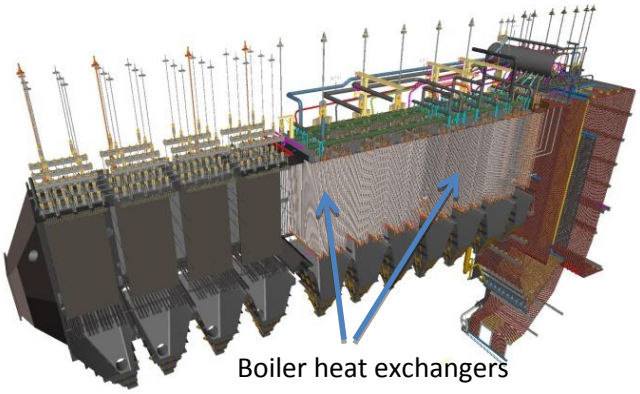

Figure 7. Boiler heat exchanger assembly stationed inside of the boiler

For calculations dynamic load factor k_d=1,5 and partial safety factor for weight loading S_m=1,35 have been taken into account. Safety factors are used to determinate the forces and momentums which are applied on the auxiliary structure. During the rotation there are 5 different positions that are analyzed in this paper. For each position it was necessary to determinate proper forces and momentum and to apply chosen safety factors on them. In this finite element analysis during horizontal position, pressure from boiler heat exchanger assembly is applied directly on U300 beams. All auxiliary structure is supported by the ground. During the rotation on positions 30°, 45° and 60° weight is distributed on the U300 and HE-B100 beams, depending on the rotation. During that time one crane is rotating while other one is holding and supporting the end, which is to remain on the ground. On the vertical finite element analysis weight is only distributed on the HE-B100 beams. Example of boundary conditions, and forces applied on the frame is show on the horizontally placed auxiliary structure in Figure 8.

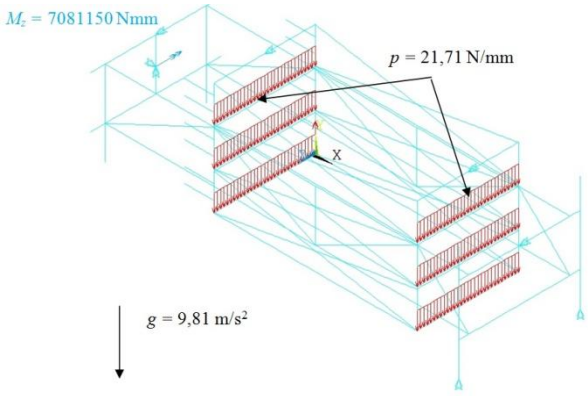

Figure 8. Illustration of boundary conditions of the auxiliary structure positioned horizontally

Data from finite element analysis is taken and for each position tested if auxiliary structure will manage to endure the weight of the boiler heat exchanger assembly. The displacement of the beams in *x* and *y* direction is tested as well as the stress on the auxiliary structure. Example of these calculations is shown on 60° rotational position:
Allowed displacement on *x*-axis is:

$$u_{\text{all}} = \frac{l}{250} = \frac{2460}{250} = 9{,}84\ \text{mm}, \quad u = 2{,}627\ \text{mm}, \quad u < u_{\text{all}} \rightarrow \text{Ok!} \tag{4}$$

Allowed displacement on *y*-axis is:

$$w_{\text{all}} = \frac{l}{250} = \frac{2460}{250} = 9{,}84\ \text{mm}, \quad w = 2{,}828\ \text{mm}, \quad w < w_{all} \rightarrow \text{OK!} \tag{5}$$

Allowed stress:

$$\sigma_{\text{all}} = \frac{R_e}{1{,}1} = 204{,}5\ \text{MPa}, \quad \sigma_{\max} = 104{,}11\ \text{MPa}, \quad \sigma_{\max} < \sigma_{\text{all}} \rightarrow \text{OK!} \tag{6}$$

After all the calculations of the auxiliary structure, in all 5 different positions it has been determinate that the structure was able to endure the process of montage.

3. Results

This paper goal is to find out the position during the rotation which has higher values of stress and displacement then other, so that during further analysis it would be necessary only to do those critical positions without doing this extensive analysis of 6-7 different positions. That position is to be further called as the critical position of the auxiliary structure during this kind of montage. To determine the critical position it is necessary to select different beams. The auxiliary structure is symmetric around the *x*-axis, so it is only necessary to select a beam from one side of the symmetry. On figure 9 it is shown an illustration of the beams that are selected for this process of finding out the critical position.

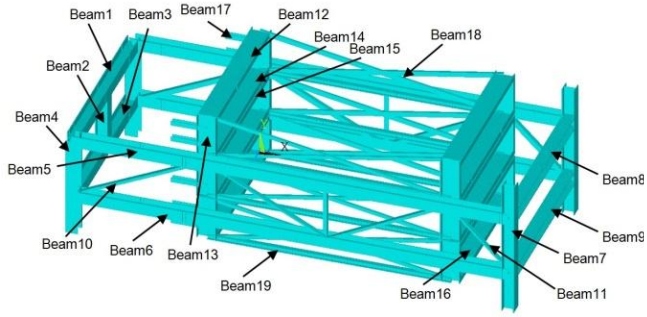

Figure 9. Illustration of the selected beams that are shown in the result graphs

All the data gained through finite element analysis has closely been collected and used to make graphs that can be used to determine the critical position. All graphs have same *x*-axis, which is angle of rotation in degrees. Figure 10 show colors and marks on the lines used in the graphs.

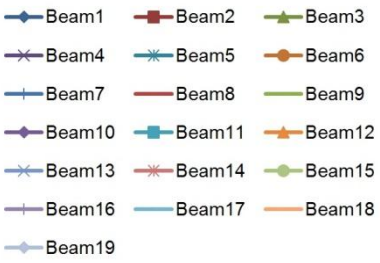

Figure 10. Marks and colors of the lines used in the result graphs

Maximal values of axial forces occur in the position of the 30° on beams 6 and 13. Rest of the data shows that the highest values of axial forces are in horizontally positioned auxiliary structure as shown in figure 10.

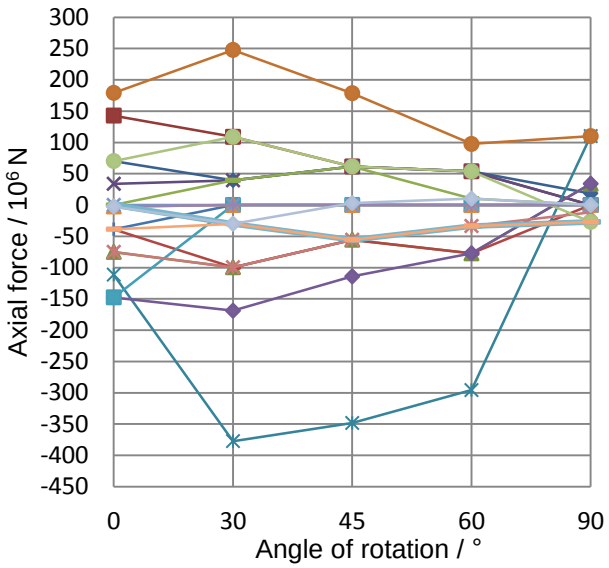

Figure 11. Graph which shows change of the axial forces in the selected beams during the rotation of the auxiliary structure

Bending moment in y-direction in the auxiliary structure is the highest in vertical and horizontal position. As y-axis is the one which is aligned with the auxiliary structure when is positioned vertically it is normal to see the highest values of the bending momentum in the y-direction in vertical position as shown in figure 12. Same goes for horizontal positioned auxiliary structure and x-axis as shown in figure 13.

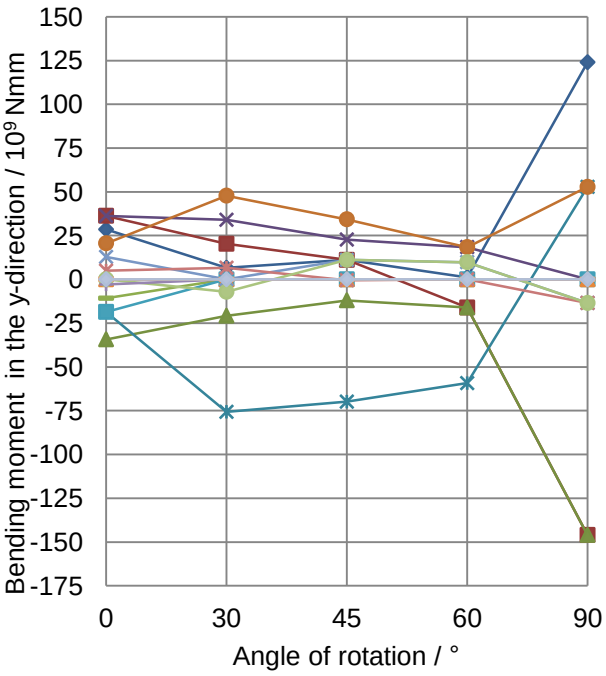

Figure 12. Graph which shows change of bending moment in the y-direction on the selected beams during the rotation of the auxiliary structure

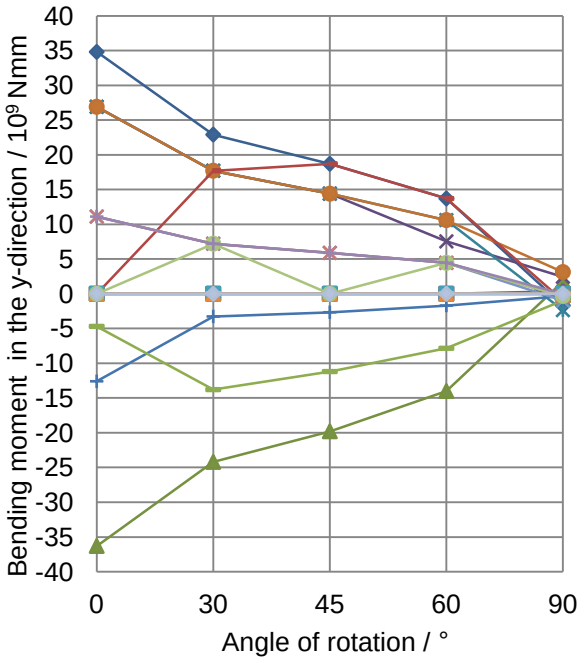

Figure 13. Graph which shows change of bending moment in the y-direction on the selected beams during the rotation of the auxiliary structure

The most important graph in this finite element analysis is the one that shows change of von Mises stress. As shown in figure 14, highest values of von Mises stress occurs while the auxiliary structure is placed horizontally and vertically.

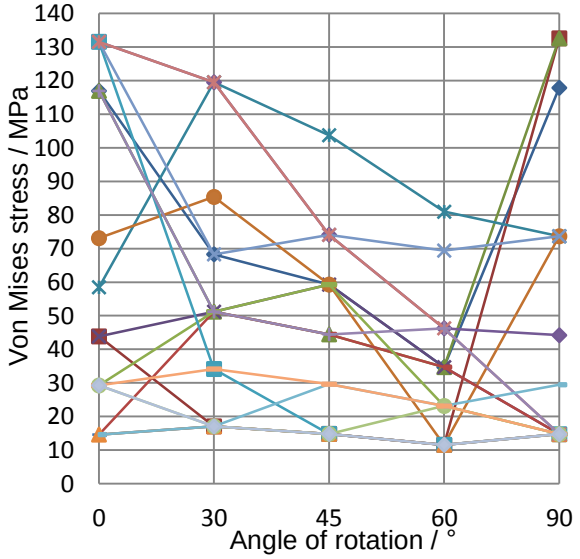

Figure 14. Graph which shows change of von Mises stress on the selected beams during the rotation of the auxiliary structure

Considering displacement it is visible in figure 15 that the highest values of the displacement in x-direction is while the auxiliary structure is placed vertically. Displacement in the y-direction has the highest values in the rotational position of 30° of the auxiliary structure.

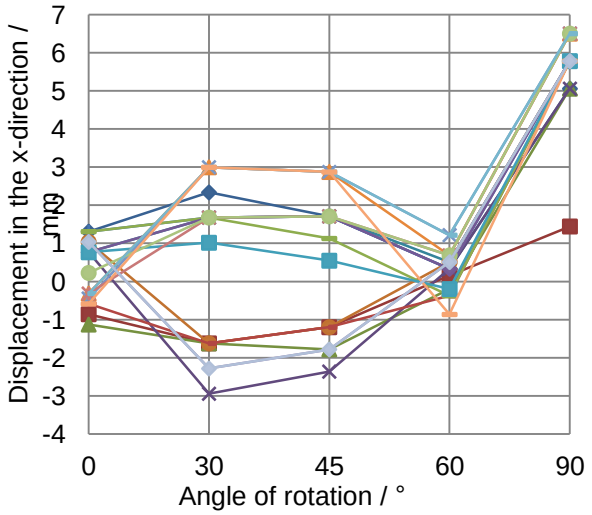

Figure 15. Graph which shows change of displacement in the x-direction on the selected beams during the rotation of the auxiliary structure

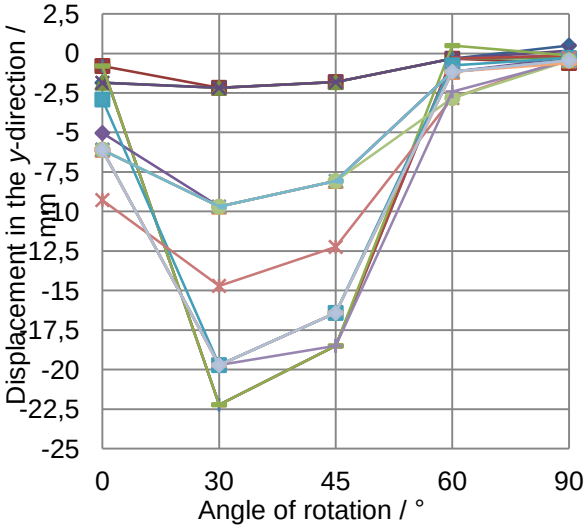

Figure 16. Graph which shows change of displacement in the y-direction on the selected beams during the rotation of the auxiliary structure

4. Conclusion

Considering von Mises stress and the displacement in the *x*-direction it is visible that the critical position is the one when auxiliary structure is placed vertically. Furthermore, considering displacement in the *y*-direction and values of the axial forces as well as high displacements in the *x*-direction during the angular position of 30° of the auxiliary structure there is a need for its analysis when we have a high need for stiffness of the auxiliary structure. Considering only von Mises stress there is a high value occurring when the auxiliary structure is positioned horizontally. Comparing horizontally placed and 30° angular

positioned auxiliary structure during the finite element analysis it is visible that horizontally placed auxiliary structure has more support than the one that is tilted. In this kind of situations strength of the auxiliary structure is more important than its stiffness. So, concluding this we could say that critical positions are ones where higher stress occurs and that is when auxiliary structure is placed vertically and horizontally.

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APPLICATION OF DIFFERENT SEGMENTATION APPROACHES ON CB-CT IMAGES FOR THE RECONSTRUCTION OF 3D MODEL OF MANDIBLE

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Abstract
The segmentation process of medical CT images today is a very important, but also a very complex problem which attracts great attention of researchers from various fields. This paper presents application of two different approaches of segmentation tested on Cone Beam CT images of the human mandible. Investigation is primarily aimed at shortening the time required for post-processing of the segmented images (filtering, removing unnecessary noise, modifying the segmented boundaries of objects, etc.).

Keywords:
image processing, CB-CT, segmentation, 3D model reconstruction

1. Introduction

With recent advances in computer technology, medical images generated by systems such as magnetic resonance imaging (MRI), computed tomography (CT) and others, provide an effective means for noninvasive mapping of anatomical and physiological structures of the human body. Therefore, they play an increasingly important role in the field of medicine but in dentistry as well, especially in the cases of bone defects in jaw region [1].

Significant research efforts are dedicated to the processing and analysis of medical images in order to extract important information, such as the geometric characteristics and objects 3D volume data, for the purposes of detecting abnormalities and quantification of changes in the follow-up studies [2]. The analysis of medical images represent an increasing need for automated segmentation methods of human organs and complex sub-structures from large data sets of multi-dimensional images [3].

The need for accurate tools for segmentation in medical applications is driven by an increase in the capacity of the device that is used to generate images. Common systems, such as CT and MRI, generate images that due to high resolution and a large number of images simply cannot be manually processed and analyzed. In addition, it is very difficult to visualize complex structures in three-dimensional volumes without removing the parts that are, perhaps, of significance. Tools, such as segmentation, are allowing medical staff to analyze such large sets of images by distinguishing objects that are of particular importance. In addition, segmentation allows to export 3D models of bones, organs, tumors and other objects for their further analysis, quantification and simulation [4].

Besides being one of the most important tasks for application in many medical applications, segmentation is also one of the most sensitive. It aims to extract regions or objects on medical images, as well as to isolate several anatomical structures that are of interest, which are located on the images [5].

Algorithms for segmentation of medical images play a vital role in numerous biomedical applications for image processing such as quantification of tissue volumes, diagnosis, localization of disease, the study of anatomy, treatment planning, partial volume correction of functional data as well as computer supported surgery [3].

Segmentation techniques are used to separate the region of interest (ROI) from the remainder of the image. The segmentation is critical as it presents a major step in separation between ROI and the background and thus, has a major effect on the geometric accuracy of the 3D model [1].

2. Materials and Methods

This paper presents approach where the reconstruction of the mandible, based on the Cone Beam CT (CB-CT) images, significantly reduces the time required for post-processing of the data after the segmentation process.

One of the problems that occur during the segmentation of the mandible is that in some cases, when applying the same set of parameters during the segmentation process, the results are not satisfying for the geometric and visual representation of both the teeth and the jaw bone.

This is due to the fact that changing the parameters, as in defining the numerical values of upper and lower limits of pixel gray-level value which are the main keys for the segmentation process, leads to an increased level of noise and

other artifacts both on the teeth, or on the jaw bone.
Figure 1 shows the result of the segmentation of the lower jaw where irregularities can be clearly observed (porosity of the bone and/or noise) using a single set of parameters for segmentation.

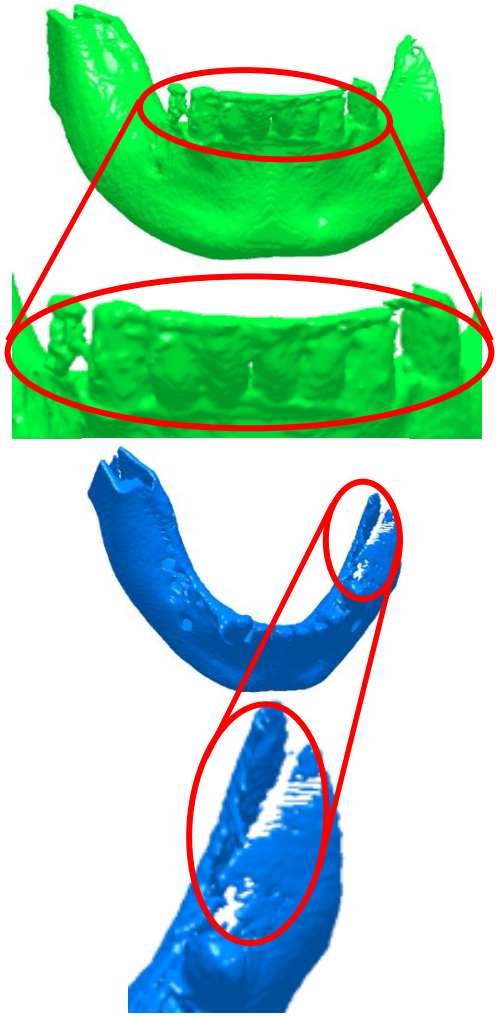

Figure 1. Inadequate parameters in the segmentation of the mandible

During the segmentation of the mandible, while defining optimal values of the upper and lower limits of the pixels gray-level value, it was found that when changing these parameters, in order to provide a more accurate visual and geometrical representation of the jaw bone, a degradation in the visual and geometrical representation of the teeth occurs while doing that, and vice versa.
In order to reduce the post-processing time of segmented objects after segmentation method, an algorithm is presented in Figure 2.

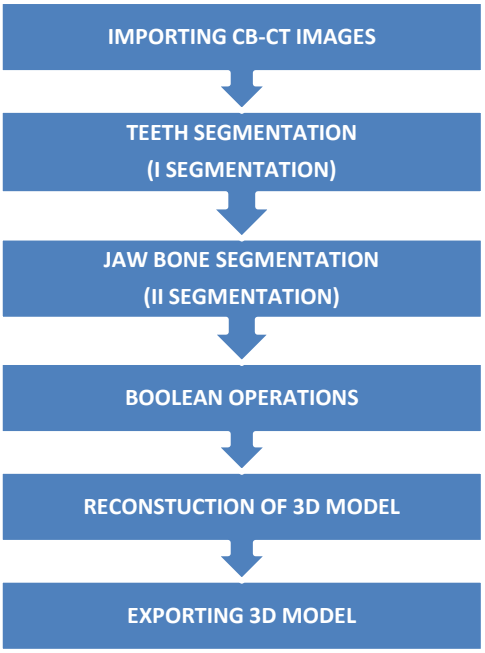

Figure 2. Algorithm

The algorithm describes the procedure where the two separate segmentations of both the teeth and jaw bone is performed using different parameters. Then, by applying Boolean operations, their merging is performed (union of two objects) in order to generate a 3D model of the complete mandible.
By applying this approach, the time required for image post-processing of the mandible is shorter, due to the fact that there is less noise on the teeth and jaw bone compared to the originally presented segmentation, where only one set of segmentation parameters has been used. This whole process is performed in software called 3D DOCTOR, but here is generally presented segmentation procedure without going into any specific details. More detailed information about the segmentation procedure in the 3D DOCTOR software is given in [6].
When defining objects for segmentation, two objects of interest has been taken into account, and those are the teeth and jaw bone. In this step, their visual interpretation is defined in a different color palette.
3D DOCTOR supports the drawing of multiple boundaries at the same time, so that the region for segmentation can be defined as a closed contour, or a region with islands or holes [6]. When defining the ROIs for segmentation process, it is necessary to pay attention to the sketching of only objects of interest, in this case, the teeth and the jaw bone (Figure 3).

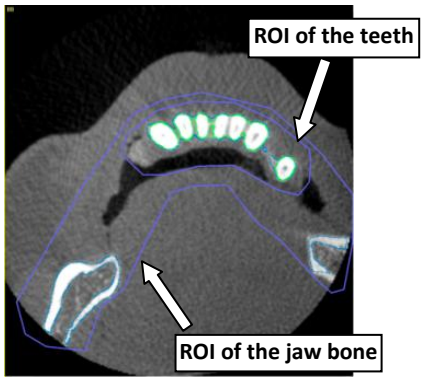

Figure 3. ROI of teeth and jaw bone

After sketching the ROI around the object of interest, an interactive segmentation is performed of the currently active image in order to extract object boundaries. The user defines the critical value that splits the pixels into visible and invisible. The result is a rendered image on the screen composed of all visible pixels. By selecting options for segmentation in a dialog box, it displays pixels gray-level value within the minimum and maximum threshold range, inside a defined ROI. Using the horizontal slider it is possible to increase/decrease the density of visible pixels which are taken into account during segmentation process (Figure 4).

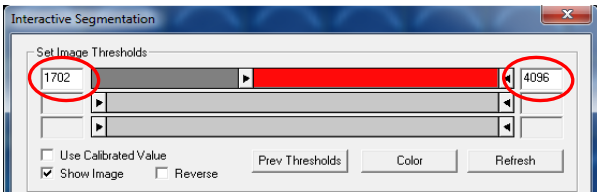

Figure 4. Dialog box for interactive segmentation

Table 1 presents the parameters that were used in the separate segmentation process of teeth and jaw bone. It shows the minimum and maximum gray-level value of pixels that was applied, and the range of images in which teeth and jaw is located, and to which these parameters are applied, respectively.
After brief inspection it was concluded that the parameters for pixel gray-level value, shown in Table 1 give the best results for separate segmentation of each object (teeth and jaw bone), and as such they are used in the segmentation process.

Table 1. Parameters used in the segmentation process

	Range of images	*Pixel threshold value*	
		Min.	*Max.*
Teeth	*88-110*	*1500*	*4096*
Jaw bone	*0-88*	*1268*	*4096*

3. Results

After the separate segmentation of both the teeth and jaw bone 3D models are shown in Figure 5. However, due to the use of the two separate segmentations, the two objects are not connected. Therefore, the Boolean operations were used where as a result, a 3D model of the mandible is generated. In the area of contact of these two models, due to the application of two different parameters, boundaries are approximated on the basis of these two models, thus generating a new 3D model.

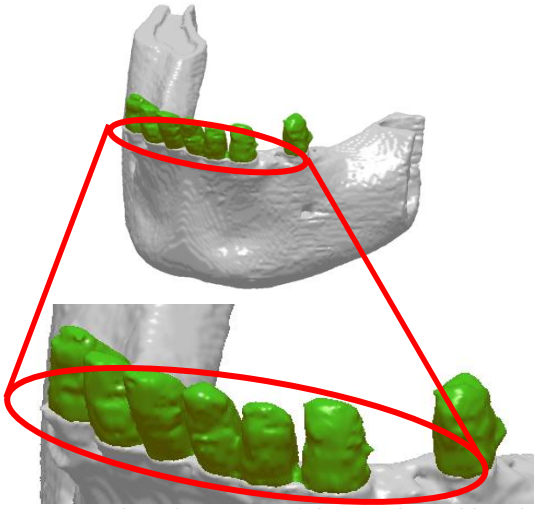

Figure 5. Point of contact of the teeth and jaw bone

Using a *Combination* command on two selected objects, the Boolean operators, such as subtraction, intersection, union, or negative, are applied. In this case, the union of two objects is used (teeth and jaw bone). As a result of this operation, a new 3D model is generated. In the *Combine Objects* dialog box two objects are first selected on which to perform Boolean operations. After that, the desired operation is chosen and the name of the new object is defined.
After this operation a new object is generated with its borders shown in Figure 6. It shows the borders of the new object, overlapped with a) the borders of the teeth, b) the borders of the jaw bone, and c) the place of intersection of the two boundaries. Here as a result of Boolean operations, the new boundaries of the new object are approximated in the intersection of two previously defined objects (teeth and jaw bone).

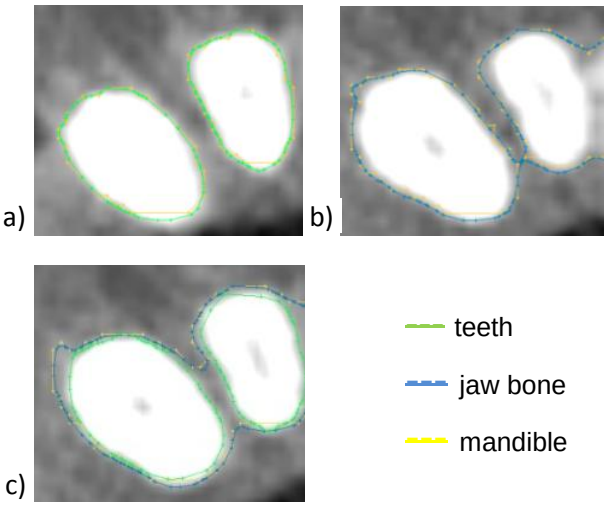

Figure 6. Showing boundaries of the new object with: a) teeth b) jaw bone, and c) intersection of the two boundaries

4. Discussion

After the boundaries of the new object are defined, the next step is to generate a 3D model of the mandible. After that an inspection is performed.

In Figure 7 is shown inspection of the two 3D models which shows small dimensional deviations of the newly generated 3D model, compared to the 3D model of separate objects (teeth and jaw bone). The deviation is present only in the line of boundary approximation (the place where two objects intersect). From the Figure 7 one can see that the maximum and minimum deviation is in the range of +0,140 mm to -0,192 mm.

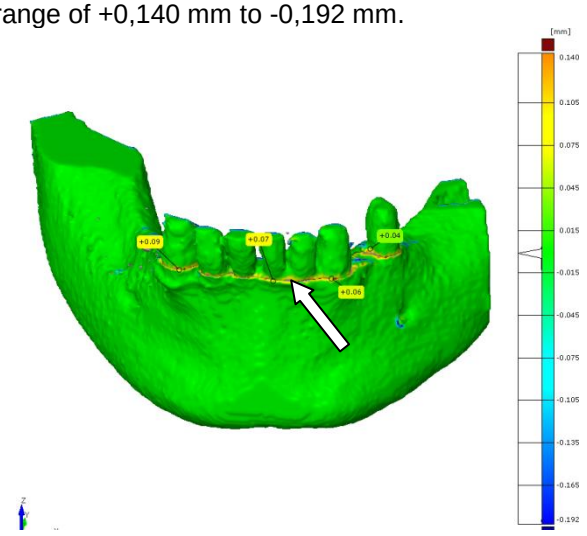

Figure 7. Inspection of the 3D model of the mandible compared to the 3D models of the teeth and jaw bone

After generating a 3D model of the mandible (Figure 8), it is then exported in some of the file formats provided by the software 3D DOCTOR such as (.stl), (.dxf), (.igs) [6].

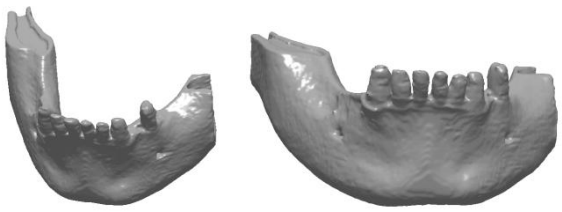

Figure 8: Finished 3D model of the mandible

5. Conclusion

The new approach was introduced in the segmentation process of the mandible based on CB-CT images where the application of multiple segmentations and Boolean operations were used in order to generate a fully functional 3D model of the human mandible. With this approach, the time required for the image post-processing process is significantly reduced, which is also the main advantage of this approach. Also, the results of the dimensional analysis are a good indicator of the applicability of this approach. Further research may include, on one hand a more detailed applicability of the proposed approach in medical and dental applications, and on the other hand, the more elaborate analysis of the geometric accuracy of the 3D models generated by applying this approach.

Acknowledgement

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ANALYTICAL STUDY OF STRESS

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Abstract
The article deals with general problems of the mechanical (elastic and viscous) stress. We consider the stress intensity factors at the origin of cracks. Using the polar coordinate system, we demonstrate a mathematical approach to stress problems.

Keywords:
stress, origin of cracks, intensity factor

1. Introduction

A few decades ago, constructions and components were designed using only classical strength calculations. Despite careful calculations, damages were repeatedly appearing on bridges, ships, aircraft, tanks, reactor components and pipelines with sometimes catastrophic consequences.
Damages that are caused by mechanical stress, are in general small voids and cracks. When these cracks reach a critical size, they spread out rapidly. Cracking or crack formation is in this case a local event in the microstructure, which is by, for example, crystal defect.

2. Stress Distribution of Cracks

Starting point of fracture mechanics analysis is the elastic stress field in the vicinity of the crack tip. The exact determination of the stress distribution of cracks is possible for some crack configurations based on idealism (crack = mathematical average) and plan appropriate models with the methods of continuum mechanics. For such solutions, approximate expressions can be found which are valid only in the immediate vicinity of the crack tip. By the introduction of polar coordinates r, φ at the crack tip (Fig. 1) arise series expansions for the crack tip stress fields that are dependent on the factor $\mathrm{r}^{(\mathrm{n}/2)-1}$ with $\mathrm{n}=1,2,3\ldots$

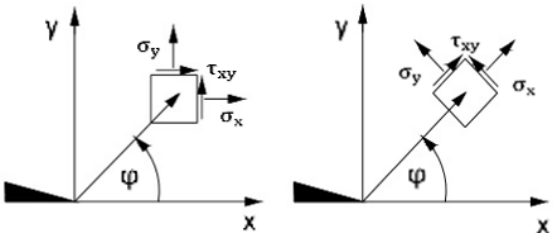

Figure 1. Coordinate systems and stress components at the crack tip

Considering only the first term of the series (with $r^{-1/2}$), it follows:

$$\sigma_{ij} = -\frac{1}{\sqrt{2r\pi}}\left[\mathrm{K_I f_{ij}^{I}}(\varphi) + \mathrm{K_{II} f_{ij}^{II}}(\varphi) + \mathrm{K_{III} f_{ij}^{III}}(\varphi)\right] \quad (1)$$

for $i, j = x, y, z$ (see [3]). These approximate equations are valid for all linear-elastic solutions of crackproblems in homogeneous isotropic bodies. $\mathrm{f_{ij}^{I}}$, $\mathrm{f_{ij}^{II}}$ and $\mathrm{f_{ij}^{III}}$ are dimensionless functions containing only the angle φ.

The parameters $\mathrm{K_I}$, $\mathrm{K_{II}}$ and $\mathrm{K_{III}}$ are the stress intensity factors(see [5]), each associated with one of the three basic types (modes) of stress crack (Fig. 2) :

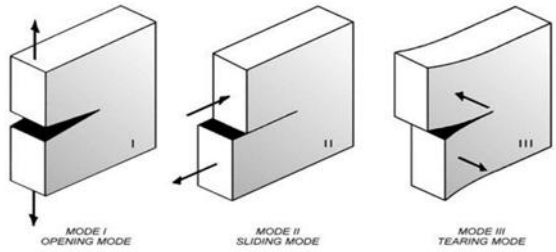

Figure 2. The tree basic modes of cracks surface displacements

Mode I or opening mode, the body is loaded by tensile forces, such that the crack surfaces are pulled apart in the y direction. The deformations are then symmetric with respect to the planes perpendicular to the y axis and the z axis, stress intensity factor $\mathrm{K_I}$;

Mode II or sliding mode, the body is loaded by shear forces parallel to the crack surfaces, which slide over each other in the x direction. The deformations are then symmetric with respect to the plane perpendicular to the z axis and skew symmetric with respect to the plane perpendicular to the y axis, stress intensity factor $\mathrm{K_{II}}$;

Mode III or tearing mode, the body is loaded by shear forces parallel to the crack front the crack surfaces, and the crack surfaces slide over each other in the z direction. The deformations are then skew-symmetric with respect to the plane perpendicular to the z and the y axis, stress intensity factor K_{III}.

The stress intensity factors describe the intensity of the stress field close to the crack, but not its distribution. They are therefore dependent on the type and size of the outside stress, the crack length and the remaining dimensions of the component, but independently of the polar coordinates. It is well known that for any plane problem of elastic balance there is a function Φ that satisfies the conditions of balance. It showed British astronomer George Biddell Airy (1862.), so the function Φ is called Airy stress function(see [4]).

The connection between function Φ and stress components in the case of plane stresses is:

$$\sigma_x = \frac{\partial^2 \Phi(x,y)}{\partial y^2} \quad (2a)$$

$$\sigma_y = \frac{\partial^2 \Phi(x,y)}{\partial x^2} \quad (2b)$$

$$\tau_{xy} = \frac{\partial^2 \Phi(x,y)}{\partial x \partial y} \quad (2c)$$

The equilibrium equations (Navier equations) for plane stress are:

$$\frac{\partial \sigma_x}{\partial x} + \frac{\partial \tau_{xy}}{\partial y} = 0 \quad (3a)$$

$$\frac{\partial \sigma_y}{\partial y} + \frac{\partial \tau_{xy}}{\partial x} = 0 \quad (3b)$$

From Hooke law follows:

$$E\varepsilon_x = \sigma_x - \nu\sigma_y \quad (4a)$$

$$E\varepsilon_y = \sigma_y - \nu\sigma_x \quad (4b)$$

$$\frac{E\gamma_{xy}}{2(1+\nu)} = \tau_{xy} \quad (4c)$$

Based on Cauchy equations deformation - displacement:

$$\varepsilon_x = \frac{\partial u}{\partial x} \quad (5a)$$

$$\varepsilon_y = \frac{\partial v}{\partial y} \quad (5b)$$

$$\gamma_{xy} = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} \quad (5c)$$

we obtain the equation of compatibility of deformations:

$$\frac{\partial^2 \gamma_{xy}}{\partial x \partial y} = \frac{\partial^2 \varepsilon_x}{\partial y^2} + \frac{\partial^2 \varepsilon_y}{\partial x^2} \quad (6)$$

If we write the equation (3) in the function of the Airy function Φ and put them in the equation from equation (5) follows:

$$\frac{\partial^4 \Phi}{\partial x^2} + 2\frac{\partial^4 \Phi}{\partial x \partial y} + \frac{\partial^4 \Phi}{\partial y^4} = 0 \quad (7a)$$

$$\Delta^2 \Phi = \nabla^4 \Phi = \nabla^2 \left(\nabla^2 \Phi\right) = 0 \quad (7b)$$

where Δ and ∇ are differential operators Laplace operator and nabla operator:

$$\Delta = \nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}$$

Let be $Z(z)$ Westergaard function.Airy function Φ, written in function of real $\mathrm{Re}\bar{\bar{Z}}(z)$ and imaginary $\mathrm{Im}\bar{Z}(z)$ components of Westergaard function:

$$\Phi = \mathrm{Re}\bar{\bar{Z}}(z) + y\mathrm{Im}\bar{Z}(z) \quad (8)$$

satisfies the biharmonic equation (7).Differentiating the expressions (8) to give a valueof (2), may stresses σ_x , σ_y, τ_{xy} be expressed as a Westergaard function $Z(z)$:

$$\sigma_x = \mathrm{Re}Z(z) - y\mathrm{Im}Z'(z) \quad (9a)$$

$$\sigma_y = \mathrm{Re}Z(z) + y\mathrm{Im}Z'(z) \quad (9b)$$

$$\tau_{xy} = -y\mathrm{Re}Z'(z) \quad (9c)$$

where $Z'(z)$ the first derivation of the Westergaard function Z is.

According to Figure 1, the boundary conditions are:

$$x = \pm\infty \rightarrow \sigma_{(\infty)} = \sigma_x \;;\; y = \pm\infty \rightarrow \sigma_{(\infty)} = \sigma_y \;;$$

$$y = 0,\ -a < x < a \rightarrow \sigma_y = 0;\ x = \pm a \rightarrow \sigma_y = \infty$$

A function that satisfies all of these boundary conditions can be written as:

$$Z(z) = \frac{\sigma \cdot z}{\sqrt{z^2 - a^2}} \quad (10)$$

where $z = re^{i\varphi}$.This function is called Westergaard stress function.By moving the coordinate system in the top cracks and replacing z by $(z+a)$, expression (10) becomes:

$$\mathrm{Z}(z) = \frac{\sigma \cdot (z+a)}{\sqrt{(z+a)^2 - a^2}} \quad (11)$$

$$\mathrm{Z}'(r,\varphi) = -\frac{\sigma\left(2are^{-i\varphi/2} - a^2 e^{-3i\varphi/2}\right)}{(2ar)^{3/2}} \quad (12)$$

Based on these two equations, the real and imaginary component of $\mathrm{Z}(r,\varphi)$ and $\mathrm{Z}'(r,\varphi)$ may be rewritten as a function of (r,φ):

$$\mathrm{ReZ}(z) = \frac{\sigma a \cos\frac{\varphi}{2}}{\sqrt{zar}} \quad (13)$$

$$\mathrm{ImZ}'(z) = \frac{\sigma a\left(-2ar\sin\frac{\varphi}{2} + \sin\frac{3\varphi}{2}\right)}{\sqrt{(2ar)^3}} \quad (14)$$

For

$$re^{i\varphi} = \cos\varphi + i\sin\varphi,\ \ x = r\cos\varphi,\ \ y = r\sin\varphi$$

By setting values (13)and (14) in expressions (9) and replacing $y = r\sin\varphi$ with $2r\sin(\varphi/2)\cos(\varphi/2)$ stresses in the top of the crack can be written as (see [2]):

$$\sigma_x = \frac{\sigma\sqrt{\pi a}}{\sqrt{2\pi r}}\cos\frac{\varphi}{2}\left(1 - \sin\frac{\varphi}{2}\sin\frac{3\varphi}{2}\right) \quad (15)$$

$$\sigma_y = \frac{\sigma\sqrt{\pi a}}{\sqrt{2\pi r}}\cos\frac{\varphi}{2}\left(1 + \sin\frac{\varphi}{2}\sin\frac{3\varphi}{2}\right) \quad (16)$$

$$\tau_{xy} = \frac{\sigma\sqrt{\pi a}}{\sqrt{2\pi r}}\sin\frac{\varphi}{2}\cos\frac{\varphi}{2}\cos\frac{3\varphi}{2} \quad (17)$$

Besides, for the plain stress condition $\sigma_z = 0$, apropos $\sigma_z = \nu(\sigma_x + \sigma_y)$ for the plane strain condition.
On this way for Mode I can be written:

$$\sigma_x = \frac{\mathrm{K_I}}{\sqrt{2\pi r}}\cos\frac{\varphi}{2}\left(1 - \sin\frac{\varphi}{2}\sin\frac{3\varphi}{2}\right) \quad (18)$$

$$\sigma_y = \frac{\mathrm{K_I}}{\sqrt{2\pi r}}\cos\frac{\varphi}{2}\left(1 + \sin\frac{\varphi}{2}\sin\frac{3\varphi}{2}\right) \quad (19)$$

$$\tau_{xy} = \frac{\mathrm{K_I}}{\sqrt{2\pi r}}\sin\frac{\varphi}{2}\cos\frac{\varphi}{2}\cos\frac{3\varphi}{2} \quad (20)$$

For Mode II follows:

$$\sigma_x = \frac{\mathrm{K_{II}}}{\sqrt{2\pi r}}\sin\frac{\varphi}{2}\left(2 + \cos\frac{\varphi}{2}\cos\frac{3\varphi}{2}\right) \quad (21)$$

$$\sigma_y = \frac{\mathrm{K_{II}}}{\sqrt{2\pi r}}\sin\frac{\varphi}{2}\cos\frac{\varphi}{2}\cos\frac{3\varphi}{2} \quad (22)$$

$$\tau_{xy} = \frac{\mathrm{K_{II}}}{\sqrt{2\pi r}}\cos\frac{\varphi}{2}\left(1 - \sin\frac{\varphi}{2}\sin\frac{3\varphi}{2}\right) \quad (23)$$

For Mode III follows:

$$\tau_{xy} = \frac{\mathrm{K_{III}}}{\sqrt{2\pi r}}\sin\frac{\varphi}{2} \quad (24)$$

$$\tau_{yz} = \frac{\mathrm{K_{III}}}{\sqrt{2\pi r}}\cos\frac{\varphi}{2} \quad (25)$$

$$\sigma_x = \sigma_y = \sigma_z = \tau_{xy} = 0$$

For example:
We have some mixed-mode stresses consisting of Mode I and Mode II (see [1]):

$$\sigma_x = \frac{\mathrm{K_I}}{\sqrt{2\pi r}}\cos\frac{\varphi}{2}\left(1 - \sin\frac{\varphi}{2}\sin\frac{3\varphi}{2}\right) -$$

$$-\frac{\mathrm{K_{II}}}{\sqrt{2\pi r}}\sin\frac{\varphi}{2}\left(2 + \cos\frac{\varphi}{2}\cos\frac{3\varphi}{2}\right)$$

$$\sigma_y = \frac{\mathrm{K_I}}{\sqrt{2\pi r}}\cos\frac{\varphi}{2}\left(1 + \sin\frac{\varphi}{2}\sin\frac{3\varphi}{2}\right) +$$

$$+\frac{\mathrm{K_{II}}}{\sqrt{2\pi r}}\sin\frac{\varphi}{2}\cos\frac{\varphi}{2}\cos\frac{3\varphi}{2}$$

$$\tau_{xy} = \frac{\mathrm{K_I}}{\sqrt{2\pi r}}\sin\frac{\varphi}{2}\cos\frac{\varphi}{2}\cos\frac{3\varphi}{2} -$$

$$-\frac{\mathrm{K_{II}}}{\sqrt{2\pi r}}\cos\frac{\varphi}{2}\left(1 - \sin\frac{\varphi}{2}\sin\frac{3\varphi}{2}\right)$$

3. Stress Intensity Factors

The dependence of the stress intensity factors of the external load (normal stress σ, shear stress τ, force F), the crack length and the remaining dimensions of the loaded body in this example are represented as follows:

$$\mathrm{K_I} = \sigma\sqrt{\pi a}\,\mathrm{Y_I} \quad (26)$$

$$\mathrm{K_{II}} = \tau\sqrt{\pi a}\,\mathrm{Y_{II}} \quad (27)$$

The dimensionless functions Y_I and Y_{II} describes the influences of crack configuration, geometry of the component and type of load application.
For the internal crack in the infinitely extended disk under uniaxial tensile stress perpendicular to the crack plane (Griffith crack problem, Fig. 3) arises $Y_I = 1$ and so:

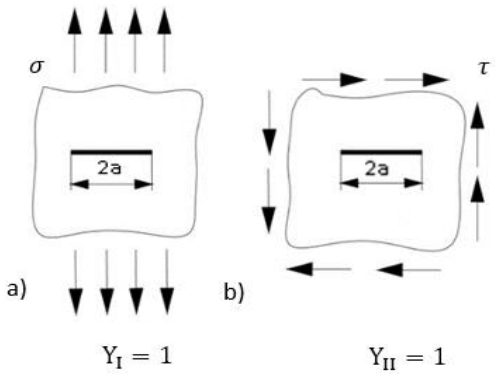

Figure 3. Infinitely extended disk with internal crack (Griffith crack problem)
a) tensile load b) thrust load

$$K_I = \sigma\sqrt{\pi a} \qquad (28)$$

In pure push stress $Y_{II} = 1$, and we obtain:

$$K_{II} = \tau\sqrt{\pi a} \qquad (29)$$

4. Conclusion

Stress intensity factors have been determined for many crack cases and also put together systematically in some work. Nevertheless, there are in practice always crack problems, for which are still not known stress intensity factors. These have to be determined by appropriate methods.

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EXPERIMENTAL AND THEORETICAL INVESTIGATION OF EFFECT OF PROCESS PARAMETER ON TEMPERATURE DEVELOPMENT DURING FRICTION STIR WELDING

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Abstract
Friction stir welding is the relatively new technique for solid state joining process. Under this process joining of material takes place below the melting point. So temperature developed during this process is dependent on process parameter. The main purpose of this study is to analyse the effect of process parameter on temperature development of AA 6101-T6 experimentally as well as theoretically. To analyse the temperature at different locations during FSW thermal imaging camera is used. Under this study maximum temperature during process is observed experimentally and theoretically which is 80% of the melting point of work piece. Experimental behaviour of temperature with time is also covered. Since temperature of advancing side of weld is 10-20 ^{0}C more than that of retracting side, so this phenomena is also invetigated experimentally during this study.

Keywords:
Friction stir welding, Temperature, Heat developed, Advancing side, Retracting side

1. Introduction:

In the year 1991, The Welding Institue (TWI) developed Friction stir welding process. The principle of this process is that it joins the material below their melting point so it comes under the category of solid state joining method. In FSW there is a non consumable rotating tool with a shoulder surface and a profiled nib. Pin plunges through the material depth and there is a surface contact between the shoulder surface and work-piece. When rotating tool moves forward heat generated due to friction causes the material to soften and thus welding action takes place. Figure 1 shows the schematic drawing of friction stir welding.

Tool's three surfaces are in contact with work-piece due to which frictional heat is generated. These three surfaces are tool shoulder's bottom surface, pin's side surfcace and pin's bottom surface [1]. Main contribution towards heat development is the friction between shoulder surface and workpiece. The peak temperature achieved during FSW is 80 % of material's melting temperature. The temperature on advancing side is slightly higher by 15-25^0 C compared to that of retracting side. For the same traverse speed, higher the rotary speed of tool, higher peak temperature is achieved. On the other hand as the rotary speed is constant, the higher traverse speed, the lower peak temperature is achieved [2].

Gabor Ramona et. al. investigated friction stir welding development of aluminium alloys for structural connections. From the temperature measurements it can be observed that a lower pitch value (λ=U/ω) produced a higher temperature, meaning that a reduced welding speed (U) in comparison with rotating speed (ω) introduces more heat, which involves an increase of the residual stresses. It also must be considered that a welding speed offers more time for the material mixture, providing free of defects connections [3].

Hamilton C. et. al. developed a thermal model of friction stir welding that utilizes a new slip factor based on energy per unit length of weld. The thermal model successfully predicts the maxium welding temperature over a wide range of energy levels but under predicts the temperature for low energy levels for which heat from plastic deformation dominates [4].

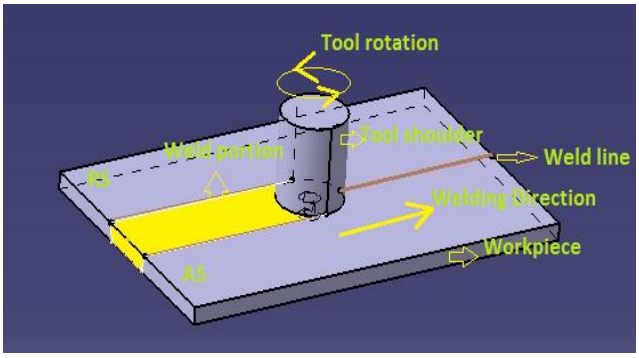


Figure 1. Schematic drawing of Friction Stir Welding

2. Experimental procedure:

2.1 Selection of material:

For this study aluminium alloy of grade 6061-T6 is selected. It is generally used in Rail coaches, aerospace application and military bridges. Chemical composition of AA 6061 is shown below in Table 1 [5].

Table 1. Composition of AA 6061

Contents	%
Cu	0.15-0.4
Fe	0.7
Si	0.4-0.8
Mn	0.15
Mg	0.8-1.2
Zn	0.25
Cr	0.01-0.35
Ti	0.15
Al	Rest

T6 - Thermally heat treated and then artificially aged.

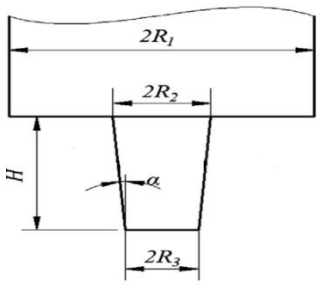
The physical and mechanical properties of AA 6061-T6 is shown in table 2 [6]:

Table 2. Properties of AA 6061

Density	2.70 g/cm³
Melting Point	650 °C
Thermal Expansion	23.4 x10^{-6} /K
Modulus of Elasticity	70 GPa
Thermal Conductivity	166 W/m.K
Electrical Resistivity	0.040 x10^{-6} Ω .m

2.2 Selection of tool:

Tool material selected is of high carbon , high chromium steel. Figure 2 shows the schematic diagram of tool and table 3 gives the corresponding dimensions.



Figue 2. Drawing of FSW tool

Table 3. Dimensions of tool

Parameters	Vaue (mm)
Shoulder radius (R_1)	12.5
Pin top radius ($R_{2)}$	3.5
Pin bottom radius ($R_{3)}$	2.5
Height of pin (H)	5.7

As per the figure 2 tool pin is tapered as per dimension and it contains threaded profile. Actual photograph of tool is given in figure 3.

Figure 3. FSW tool with threaded pin

2.3 Experimental Set-up:

A vertical milling machine (HMT, 1U) is developed for fiction stir welding set-up. The work piece (dimension- 150 mm x 100 mm x 6 mm) is clamped in the fixture tightly. The experimental set up is shown in figure 3. The experiments are carried out using the rotational speed 1000 rpm, 710 rpm and 500 rpm and welding speed as 25mm/min, 40 mm/min. Figure 4 shows the experimental setup on milling machine.

Figure 4. Friction stir welding Set Up

After experiment, six no of samples at different process parameter is prepared. Specifications of six samples are shown in table 4.

Table 4. Parameter of tested specimens

Sr. No.	Sample No.	Rotational speed (rpm)	Weld speed (mm/min)
1.	1	500	25
2.	2	500	40
3.	3	710	25
4.	4	710	40
5.	5	1000	25
6.	6	1000	40

3. Results and Discussion

3.1 Experimental results

ix no of welding specimens are prepared by varying welding speed as well as the rotational speed of tool. At the time of welding temperature is measured using infrared camera at different time intervals for all six specimens. Thermal images are

taken with the help of CHAUVIN ARNOX C.A. 1888 camera figure 5 given below:

Figure 5 Thermal imaging camera

With the help of IR images of FSW process that is taken at different location of tool during welding. After capturing the images, these images are analysed in RayCam reporting system software which supports these images. So that temperature at different position and temperature along any line can be easily found.

3.1.1 Maximum temperature

For all six specimens temperature is measured at different time and at different locations by IR camera. As per the below IR images maximum temperature could be observed.

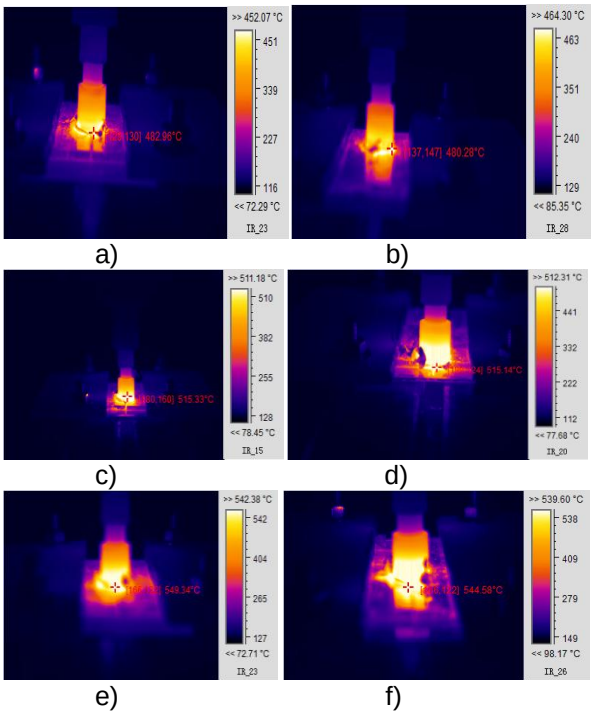


Figure 6. Maximum temperature achieved for all six specimens respectively

Maximum temperature achieved during all the six specimens are given in below table 5 as per figure 6.

Table 5. Maximum temperature achieved

Specimen no.	Fig no.	Maximum Temperature
1.	6.a)	482.00
2.	6.b)	480.33
3.	6.c)	518.57
4.	6.d)	515.4
5.	6.e)	539.07
6.	6.f)	545.09

Heat is generated during the FSW process is due to friction between the tool and work-piece. Area of friction for all the six specimens is same, but it can be observed that maximum temperature achieved is different for all the specimens. It can be observed that as the rotational speed of the tool is increased temperature increases and for the same rotational speed decrease in welding speed increases the temperature achieved. Hence for all the specimens maximum temperature is achieved in case of specimen no 6 i.e. maximum rotational speed of tool (1000 rpm) and lowest welding speed (25mm/min). Hence it can be observed that with increase in rotational speed and decrease in welding speed heat generation can be increased. Temperature achieved during FSW process is 80% of melting point of work-piece which is sufficiently enough for the FSW process

3.1.2 Time Temperature relationship

For all the six specimens temperature is observed during welding at different time intervals. Below figure 7 shows the variation of temperature with time for all six specimen. From figure it can be observed that as FSW process starts temperature starts increasing but after certain time it become constant i.e. maximum temperature of the process for the entire welding process. It can also be observed that as rotational speed of tool increases time required to attain the constant maximum temperature level decreases. For rotational speed of 500 rpm it requires 5 min to achieve maximum temperature position whereas for 710 rpm it requires 3 min and for 1000 rpm it requires 2 min.

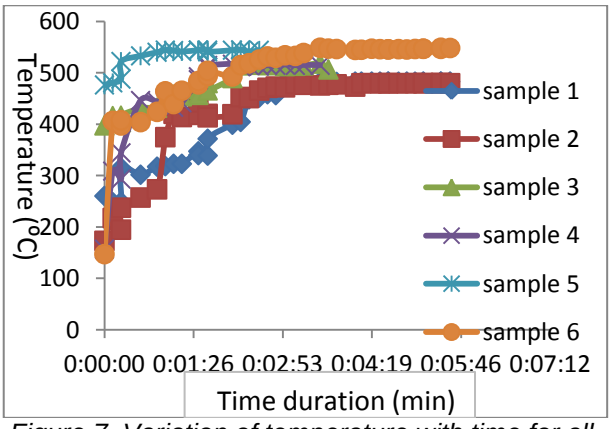


Figure 7. Variation of temperature with time for all specimens respectively

3.1.3 Variation of temperature along plate

Through the IR image taken during FSW process, temperature variation along any line drawn through work-piece could be analysed. Below figure 7 shows variation of temperature along points on any line is shown.

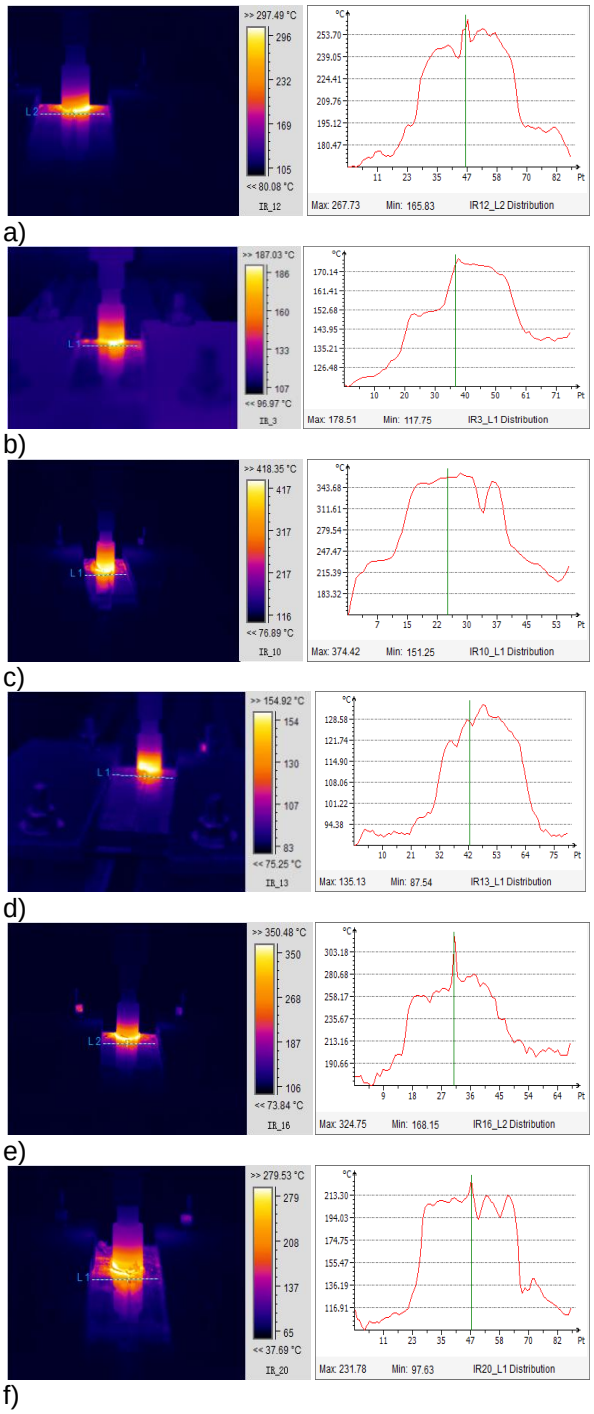


Figure 8. Variation of temperature at different points along line for all specimens respectively

In the above figure 8 variation of temperature at different points along the line drawn in IR image is shown. Since tool is rotating in clockwise direction and moves forward, so for every IR image left hand side of the tool is retracting side and right hand side of the tool is advancing side of welding. Figure 8 a) , b) , c) , d) , e) & f) shows variation of temperature at different points of the line for the specimen no 1 , 2 , 3 , 4 , 5 & 6 respectively. It can be observed from the fig no 3 that temperature of advancing side is 10-20^0 C more than that of retracting side. The reason for such variation of temperature difference is that tool swept the cooler material of advancing side to retracting side, thus cools the temperature of retracting side and conversely increases the temperature of advancing side.

3.2 Numerical verification of temperature

In this numerical verification of temperature, initially heat generated due to friction between tool and work-piece is calculated through the mathematical formula [7] and then the value of heat will be put on ANSYS 12.0 model for examining the value of temperature generated at different parts of work-piece.

The work-piece surface which contacts with the tool is defined as the heat source and it contains three parts: shoulder surface (SS), pin side surface (PSS) and bottom surface (PBS). Since heat generated due to all three parts are different so as per [7] three mathematical formula for three parts are given below.

Thus heat generated at the SS may be expressed as [7]:

$$Q_{ss}=[\delta_{ss}\tau_b+(1-\delta_{ss})\mu P].\frac{2}{3}\pi\omega(R_1^3-R_2^3) \quad (1)$$

Where,

δ_{ss} = contact state variable, in this case it is assumed to be 0.35,

τ_b = Maximum shear stress for yielding $= \sigma_s/\sqrt{3}$,

σ_s = Material yield strength=20MPa [12],

μ = co-efficient of friction, assumed to be 0.4,

P = Plunge pressure (assumed to be 10MPa),

ω = Tool angular velocity (rad/sec).

The heat generated at the PSS is written as [7]:

$$Q_{pss}=\frac{2\delta pss\pi\omega\tau b}{3tan\alpha}(R_2^3-R_3^3)+\frac{2}{3}(1-\delta_{pss})\frac{\pi\mu P1\omega}{sin\alpha}(R_2^3-R_3^3) \quad (2)$$

Where,

δ_{pss}=Contact state variable, in this case it is assumed to be 0.5,

α = Conic angle,

P_1=approximately equal to plunge pressure P.

The heat generated at the PBS will be [7]:

$$Q_{pbs}=\frac{2\delta pbs\pi\tau b\omega R_3^3}{3}+\frac{2(1-\delta pbs)\pi\mu P\omega R_3^3}{3} \quad (3)$$

Where,

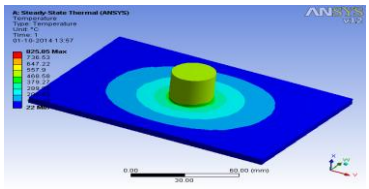
δ_{pbs}=Contact state variable, in this case it is assumed to be 0.35.

Using equations (1), (2) and (3) heat generated at the shoulder surface, pin side surface and pin bottom surface can be calculated for this study. For all the different six conditions heat generated at SS, PSS and PBS is given in below table 6.

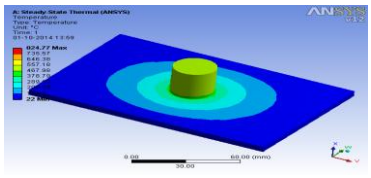
Table 6. Heat generated

Sp. no	Weld speed (mm/s)	Rotational Speed (rpm)	Heat input SS (kW)	Heat input PSS (W)	Heat input PBS (W)
1.	25	500	1.388	88.912	11.355
2.	40	500	1.386	88.791	11.339
3.	25	710	1.972	126.33	16.135
4.	40	710	1.970	126.21	16.119
5.	25	1000	2.779	178.02	22.736
6.	40	1000	2.777	177.90	22.721

As from the above table 6 it can be observed that as rotational speed increases heat input increases and for the same rotational speed decrease in weld speed increases the heat input. Now this heat input can put to ANSYS model of FSW to analyse the temperature developed on aluminium work-piece. From the below figure 8 temperature developed on ANSYS model could be seen.



a)



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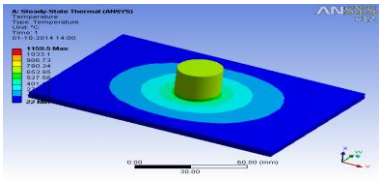
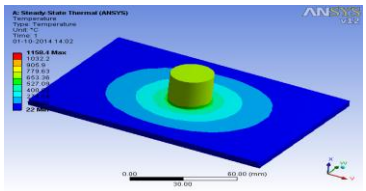
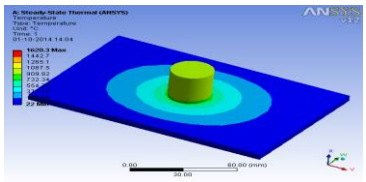


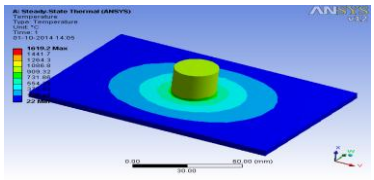
c)



d)



e)



f)

Figure 9. Temperature developed in ANSYS model for all conditions respectively

Figure 9 a) ,b) , c) , d) , e) & f) shows temperature developed in ANSYS model for the specimen no 1, 2, 3, 4, 5 & 6 respectively. Figure 10 shows comparison of experimental and theoretical value of maximum temperature developed during FSW. For sample no 1 and 2 temperature developed experimentally on work piece around tool is 480^0 C whereas through model is 460^0 C. Likewise for sample no 3 and 4 experimentally it is 515^0 C whereas through model it is 525^0 C and for sample no 5 and 6 experimentally it is 530^0 C and through model it is 700^0 C.

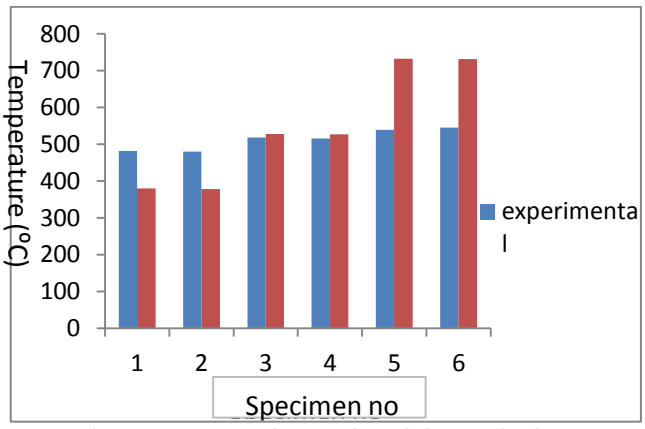


Figure 10. Experimental and theoretical comparison of peak temperature genarated during welding

The ratio of heat generation within the three parts is calculated based on equations (1), (2) and (3). They are listed below:

$$f_{ss} = \frac{Qss}{Qss+Qpss+Qpbs} = 93.26\%$$
$$f_{pss} = \frac{Qpss}{Qss+Qpss+Qpbs} = 5.97\%$$
$$f_{pbs} = \frac{Qpbs}{Qss+Qpss+Qpbs} = 0.7\%$$

The three ratios indicate that during the FSW process heat principally generated (about 93%) within the SS region and the heat generated within the PSS and PBS region only hold a very tiny portion (about 7%).

4. Conclusion

The heat generation and temperature development characteristics are investigated experimentally and theoretically under this study. Based on the results obtained from the present work, the following conclusions are drawn:

Temperature developed during FSW process is about 80% of the melting point of work piece, which is sufficient for FSW.

Temperature gradually increased as FSW process progresses and after some time it achieved the maximum temperature and constant throughout the process.

Time required achieving the maximum temperature decreases with the increase in rotational speed.

Temperature of advancing side is 10-20^{0}C more than that of retracting side, since rotating tool swept the cold material from AS to RS.

Heat developed at the shoulder surface is 93% of the total heat generated within the process; hence SS is the main source of heat generation.

Temperature achieved experimentally and theoretically at work piece during FSW around the tool is comparable.

During the FSW process no smoke or hazardous gas is developed, hence it is a green process.

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TUBE EXPANSION BY ELASTIC MEDIUM

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Abstract
One of the aims of the automotive innovations is to reduce car weight, while retaining strength. Possibility of decreasing of weight seems to be using of formed tubes as parts of load-bearing elements in car body structures. There are different technologies for modern tube forming, and tube expansion. These technologies are liquid, elastomeric and explosive operated techniques. This report presents the results of the experimental work in field of tube forming, tube expansion with elastic (polyurethane) force-transmission medium.

Keywords:
Automotive industry, car weight reduction, tube expansion, polyurethane medium

1. Introduction

A large number of tubes manufactured from different materials, diameters and wall thicknesses are applied in the automotive industry. The role of these tubes is significant in the frame structure. The most widely used tube forming processes are:
hydro-forming
electro-dynamic (electro-magnetic, and electro-hydraulic) forming
explosive forming, and
forming with elastic medium.
Forming with elastic medium is already used by the airplane industry since the early last century. In the case of large sheets, the replacement of the female mold with rubber pad was necessary from economic reasons. [1]
Kecskemét College has lots of experience and notable numbers of experimental results in similar topic: deep drawing with elastic medium. [2]
Against solid tools, during forming with elastic medium, compressive stress is generated perpendicular to the plane of the sheet, which is an important advantage in terms of ductility. In this way, the literature classifies it between the stress state exploited procedures. [3]

2. Basic information

The material was S235JR steel tube, diameter was Ø30 and wall thickness was 1 mm. Samples were prepared from the tube to determine its mechanical properties by Instron 4482 universal material tester. The results are summarized in Table 1.

Table 1. Mechanical properties of the tube

$R_{p0,2}$ [N/mm^2]	R_m [N/mm^2]	A_{80} [%]
307	425	29

Hardness of the polyurethane pad was 80 Shore A.

3. Calculation of the compressive force requirement

The base of the calculation relies on the boiler formula. In a pressurized tube, stresses are formed in axial (σ_a) and tangential (σ_t) directions (Fig. 1).

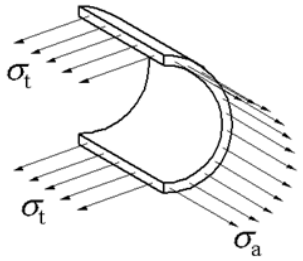

Figure 1. Axial and tangential stresses.

According to the boiler formula, σ_t can be calculated:

$$\sigma_t = \frac{D \cdot p}{2s}\ [MPa] \qquad (1)$$

where
σ_t – tangential tensile stress, awakening in the tube wall
D – outer diameter of the tube
p – internal pressure
s – wall thickness of the tube
The maximum permitted tangential tensile stress is equal with the tensile stress (Table 1). The maximum allowable compressive strength can be expressed from Eq. 1:

$$p_{max} = \frac{2 \cdot Rm \cdot s}{D}\ [\text{MPa}] \qquad (2)$$

The result is p_{max}=28 MPa. According to our measurements and literature data [1,2], the stress distribution in the polyurethane pad does not correspond to a Newtonian fluid. Our results earlier showed that the pressure which acts on the side wall is 0,8-0,9 of tangential stress. Calculation with these values, the pressure of the polyurethane pad:

$$p_0 = \frac{p_{max}}{0{,}8-0{,}9} = 31{,}1 - 35\ [\text{MPa}] \qquad (3)$$

According to the above formula the breaking compressive strength has been 19157-21551 [N],

in case of Ø28 mm compressed surface. To check the calculation, a 90mm long tube was compressed by polyurethane pad. Depending on the tool, the median 30mm was able to expand free. The breaking came about at 23000 N (Fig. 2).

Figure 2. Tube expanding up to breaking

4. Method

In our experiments, tube expanding test were done from the initial cylindrical shape to diameter Ø33, Ø34, Ø36, and Ø39, and to a square shape. The cylindrical formed tubes are shown in Figure 3.

Figure 3. Expanded cylindrical tubes

The compressive force was provided by Instron 4482 universal material tester. The forming tool is shown in Figure 4.

During our investigations compression force has acted to the polyurethane pad. Experiments of Sheng and Tonghai were performed with forces which act on the tube wall in longitudinal direction. Compared to the published data, the force-requirement of bulging is 1,4-1,5 times larger than in our case. Length reduction of the tube has happened in all cases, but in our study, the friction was responsible for it. [4]

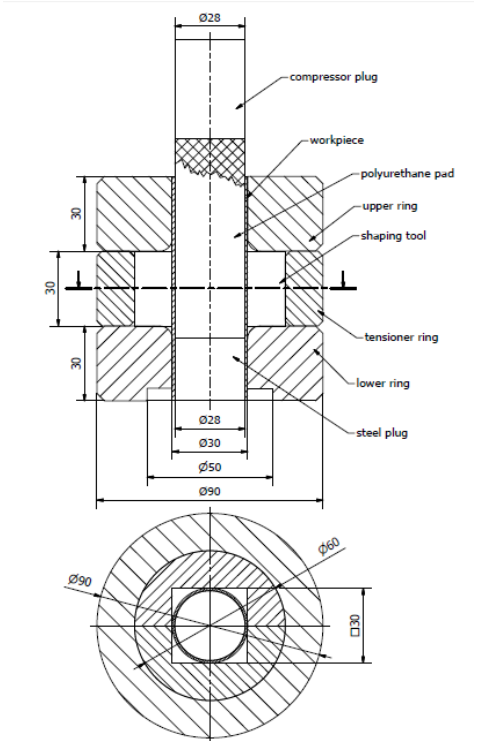

Figure 4. Drawings of the square forming tool.

Figure 5 shows the force-displacement diagram of the forming:

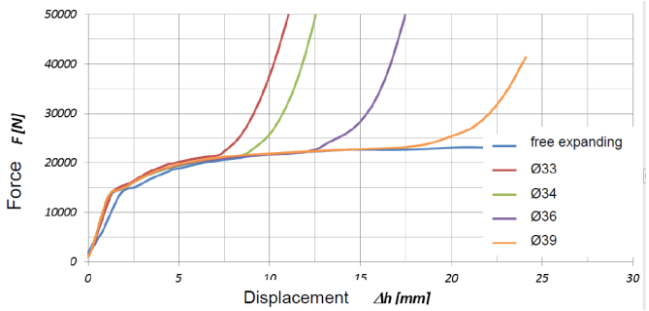

Figure 5. Force-displacement diagram of cylindrical expansion

At manufacturing of the square tubes (Fig. 6), the axial compressive strength was the maximum strength of the tester instrument. The bigger force was permitted because of minimizing of the fillet radiuses (Fig. 7).

Figure 6. Expanded square tubes

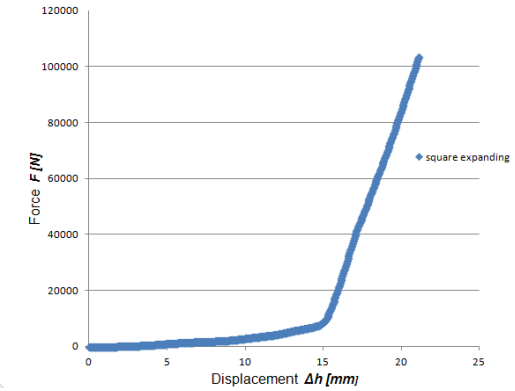

Figure 7. Force-displacement diagram of square expanding

5. Examination of the deformation

The investigated pieces were marked by measuring net. After the forming, the deformation of each segment was carried out at University of Miskolc. Their assistance is gratefully acknowledged.

The deformation of the cylindrical expansion was investigated at the largest deformed sample: Ø39. The deformation corresponds to 30%. It is well visible in different directions in Figure 8: φ_1 (red) indicates the radial, φ_2 (green) indicates the axial direction along the curve, and φ_3 (blue) refers to the wall thickness change. In the diagram, the vertical axis shows the true strain in percentage. During the forming, the length has reduced with 4-5 millimeters. Consequently, the wall thickness had to grow at the ends of the tube (φ_3), where the forming was inhibited. The wall thickness growth was about 8%. At the place of the largest diameter growth, the wall thickness thinning has occurred to 16-18%. (With the compression of the tube wall in axial direction, Sheng and Tonghai got 10% wall thinning in the largest deformed cross-section area. [4]). The greatest deforming has happened in direction φ_1, in 26-27% proportion.

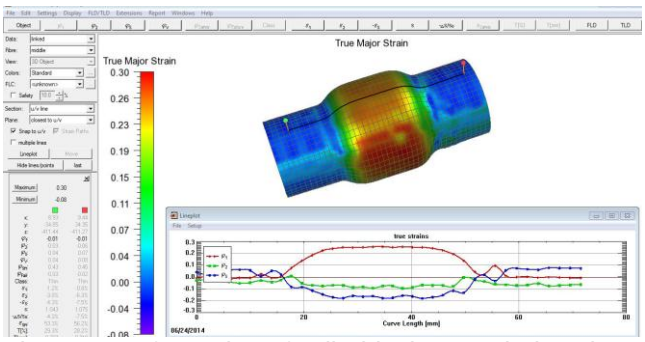

Figure 8. Deformation of cylindrical expanded work piece

The square tube expansion was done from initial cylindrical form (Ø30 mm) to square cross-section □30 mm. The deformation is well visible in different directions in Figure 9: φ_1 (red) indicates the radial, φ_2 (green) indicates the axial direction along the curve, and φ_3 (blue) refers to the wall thickness changing. In the diagram, the vertical axis shows the true strain in percentage. During the forming, the length has only changed slightly. Consequently, the deformation in axial direction was close to zero. The largest deformation has happened in direction φ_1, at the manufacturing of the corners. The deformations at the corners were 30-32%, and the wall thickening was similar due to the accumulating material from the sides.

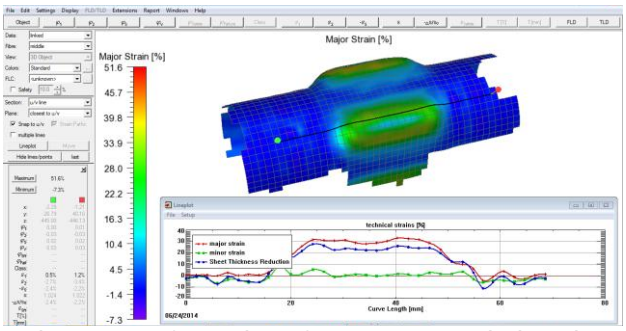

Figure 9. Deformation of square expanded work piece

6. Conclusion

Tube expansion to different cross-section can be performed with polyurethane pad, as force-transmitting medium. To set the expanding tool with polyurethane elements is much cheaper than solid tools. In addition, larger deformation is available to achive without cracking, and it does not require precise machining and high pressure used gaskets. The significance of the process is primarily reflected at small series manufacturing.

Acknowledgement

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RECYCLING POSSIBILITIES OF PROCESS RESIDUES FROM END OF LIFE VEHICLES

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Abstract
Recycling of complex technical products is a very important activity, because of national economic and also of environmental point of view. The End of Life Vehicles (ELV's) and the Waste Electrical and Electronic Equipment (WEEE's) contain beside valuable and economically recyclable metallic materials also 20-30 weight percentage of other types of mixed elements, these are mostly plastics and elastomers. Many of experimental works realised, less solution built-up as usable plants for the recycling of that type of processing-remaining-materials. This paper introduces material and energetic recycling solution possibility worked-out as a part of a five-years R&D projects realised with university and industrial partners. The thermo-catalytic conversion (TCC) is an economic way to recycle mixed processing residues from ELV's and WEEE's which was mostly landfilled until the latest periods.

Keywords:
Recycling of mixed plastics, End of Life Vehicles (ELV), Waste Electrical and Electronic Equipment (WEEE), thermo-catalytic conversion, shredding residues

1. Introduction

In the early 90-ties the European Union has monitorized the different environment-pollution impacts produced by industrial activities. During the investigations there were also analysed the impacts of complex technical products – as the End of Life Vehicles (ELV's) too - on their end-of-life status on their environment. The European Commission has reviewed the recycling process of ELV's and identified the main procedure lines. According to their investigations the wrecks will be firstly freed of fuels – all liquids and dangerous substances will be removed during the preliminary dismantling procedure – after than all usable and still saleable parts will be dismantled, qualified and sold to interesting customers. The remaining car-bodies will be mostly processed in rotating-hammer grinders, in the so called "shredders".
These equipment are preliminary constructed for the process, separation of metallic materials originated of end-of-life status complex technical products, as End of Life Vehicles, Wastes of Electric and Electronic Equipment (WEEE-Wastes). Metal content of those products represent 70-80 weight% of them.
Other not direct marketable, saleable materials came for landfilling until the latest times.
The European Commission has recognized the fact, that these non-metallic process remaining materials originated from shredders (mixed plastics-, rubber-, textile-, glass- … fractions) represent quite not much in weight, but many more in cubic capacity, what can significantly reduce the tight landfill-capacities.
For reducing the landfill-stations load the European Union has prescribed in its Directive the needed enlargement recycling ratios of complex technical products.
The 53/2000/EC so called End-of-Life-Vehicles Directive specifies the continuous enlargement of recycling ratios for materials originated of ELV-process. After 1. of January 2006 the obligation of recycling is 85% relating ELV's, 80% in material usage and 5% as energetic use. These ratios will be raised with the 1. of January 2015 up to 95% (85% material, 10% energetic).
Next article handles a development activity executed in the last 5 years for reaching the 95% recycling ratio until 01.01.2015 on the field of ELV's and WEEE-wastes.

Figure 1. Shredder equipment in Fehérvárcsurgó, Hungary, owned by ALCUFER Ltd.

2. Basic function of shredders

Basic conception of shredders was worked out in the fifties of last century, main target was to reach the recycling of metal content of ELV's. Maybe not unintentional is, that todays these equipment are called as „Automotive Shredders". So the basic methodology of process very simple is, nothing special has changed in the last 60 years.
End-of-life products will firstly be freed of dangerous substances (flammable- and explosive-, respectively environment polluting components, for

example fuels, batteries, elements of climate equipment, airbag- and pyrotechnic parts will be removed) than the preliminary dismantled car-body will be loaded in the closed shredding area. Here the rotating big hammers shredding the car-bodies on a man-fist size and the grinded material will be separated with different separation technologies into already usable fractions.
Whole process is squired with dust-detachment (both from closed shredding area and also from further manipulation areas too), this uses dry-cyclone technology to remove the dust-, foil- and sponge fractions. These fractions – the so called „shredder-fluff", namely shredding light fraction – today are going nearly exclusive for landfilling into special monodepony stations (from communal waste-streams devided working) to depose.

Figure 2. Shredder fluff-fraction, landfilled in special landfill-stations

Finest powder-fractions are separated with Venturi-Washer, this sludge will be removed into containers and threatened as dangerous waste-fraction. Basic technology continues than in a big performance magnetic drum, where depending on the consistence of processed material (in case of ELV's it means 70-75 weight% generally) the magnetizable steel- and iron fractions will be separated.
This is the main product of shredders, which will be than after manual separation for removing the remaining copper- and textile parts out of ferrous fraction delivered to foreign iron- and steel furnaces in direct-train-carriages.
Non-magnetizable materials will firstly be separated according to their size (18 mm drum-sieve separator), than get into Eddy-current separator to divide the non-ferrous and precious metals from the mixed plastics-, rubber-, stone-, textile- and wood fractions containing "shredding light fractions".

Figure 3. Mixed plastics-, rubber-, textile- fractions, the so called „Shredder light-fraction"

This shredding light fraction represent with the dust- and foil-type (shredder-fluff) waste together average 25 weight% of total processed waste and until the latest time they have been stored in special mono-type landfill stations.
Be based on a prevailing 1.400 PS performance, Zerdirator-type automotive shredder, this equipment is able to process 100.000 metric tons of wastes in one shift/day working-order. Processed in a one-day-one shift 3-500 metric tons, with input material depending 35-70 metric tons/hour flow, yearly 75.000 metric tons of steel-, iron-, nor-ferrous- and precious metals waste are delivered to metal furnaces. But at the same time there will also be 25.000 metric tons of low-density, high-volume waste deposed in the even sinking volume capacity landfill stations. In Hungary there are three of that type/size shredders working (2 in Budapest, 1 in Fehérvárcsurgó, 80 km west direction from Budapest), they are producing with full-capacity work yearly 75.000 metric tons of non-recyclable wastes. 300 in the EU, 500 worldwide of these shredders are in usage, those split in the categories between 1.000-11.000 PS performance. Only for comparison an 11.000 PS shredder with one-shift activity can treat 700.000 metric tons of input material with full-capacity usage and the amount of non-recyclable process residues can reach an amount of 175.000 metric tons!
So the 300 shredders in the European Union produce yearly 9 million metric tons of non-recyclable wastes which goes for landfilling. No wonder that the decision-makers of the EU saw the trends, has worked out new regulations (EU-Directives) which from one side prescribed a growing recycling ratio for complex technical product wastes, from the other side prohibited the landfilling of organic material residues.
So came into existence the 2000/53/EC ELV-Directive, 2002/96/EC WEEE- (Waste Electrical and Electronic Equipment Directive, as well as 1999/31/EC Landfill-Directive.

These regulations created the possible enforceability of producer product-responsibility, determined the main-recycling flows of individual end-of-life technical products, as well as they prescribed to concrete dates attached to the grow of expected recycling-ratios.

3. Developments in the post-shredder technology

One of the most significant research in the last five years in this topic run in the EU 7th R&D Framework Program under the consortium managed by Delft University, Holland. Target of the by 12-member international consortium executed „Magnetic Sorting and Ultrasound Sensor Technologies for Production of High Purity Secondary Polyolefins from Waste", W2Plastics short acronym named project was to develop an ultramodern separation technology for the shredding light fractions to be able to sort the polyolefins (polyethylen- and polypropylen) and to promote their material recycling.

Figure 4. Magnetohydrostatic separator built-up in the EU7 project W2Plastics at Delft University, Holland

Project started at the end of 2008 has finished at 30. April 2013 with the successful test-period of prototype in Brasow, Romania. In the project as Hungarian members three institutions of Budapest University of Technology and Economics, namely the Department of Polymer Engineering, Department of Organic Chemistry and Technology and the Advanced Vehicles- and Vehicle-Control Knowledge Centre and the biggest Hungarian waste-handler company ALCUFER Ltd. has participated, in individual measurements also the University of Miskolc, Institute of Raw Material Preparation and Environment Processing contributed. These experiences can be further used by the future build-up of magneto-hydrostatic separator in the ALCUFER Ltd. Fehérvárcsurgó shredding plant in Hungary. This new separation unit could be added to the already achieved separation-line. The planned time schedule for it is the second half of 2015.

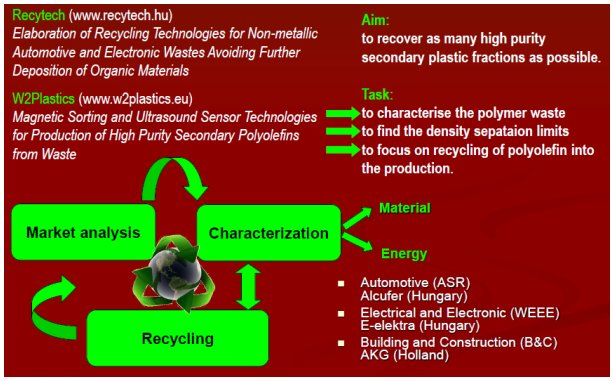

Figure 5. International and domestic developments on the Automotive and Electronic Waste fields

This can enable the further grow of material usage within the expected recycling-ratio. Further information related the project is be found on the side www.w2plastics.eu.

For the promotion of utilisation of shredding light fractions the ALCUFER Ltd. has realised successful projects in Hungary with involvement of university partners, research institutions and Hungarian Small and Medium Enterprises.

Project „Elaboration of Recycling Technologies for Non-metallic Automotive and Electronic Wastes Avoiding Further Deposition of Organic Materials" shortly named as RECYTECH was achieved with the promotion of National Research and Technology Office (NKTH – today National Innovation Office) National Technology Program found between 01.01.2009-31.12.2012. The 6-member consortium leading by the project- and consortium leader ALCUFER Ltd. worked out two plans of prototypes, mostly in framework of basic-, partly in applied research project.

Figure 6. Separation-technology prototype at ALCUFER shredding-plant Fehérvárcsurgó, Hungary

Separation technology prototype is able to sort the mixed, previously landfilled fractions at a level, that after separation of remaining metal content a very clear, organic-material-reach fraction will be achieved, which can be used for further energetic utilization. Other prototype is able to process/convert the in the previous separation procedure remaining, in organic components rich mixed plastics- and rubber during thermo-catalytic conversion technology (pyrolysis) into gas, oil and coke fractions. More about the targets and result of project can be found on the site www.recytech.hu.
In RECYTECH project worked out prototype plans were grounds for the ALCUFER Ltd. follow-up project in the Economy-development Operative Program.
Project signed with GOP-1.1.1-08/1-2008-0061, named with "Realization of complex waste-treatment system, enabling the material- and energetic utilization of End-of-Life Vehicles and Wastes of Electric and Electronic Equipment process remaining materials" has held between 01.08.2011-30.06.2012. In this period University of Miskolc, Institute of Raw Material Preparation and Environment Processing has built up the by own developed separation technology prototype which was mounted in a special for this reason built-up 1.000 qm industrial workshop in the ALCUFER Ltd. Fehárvárcsurgó shredder plant.

Figure 7. Thermo-catalytic conversion technology prototype at ALCUFER shredding-plant Fehérvárcsurgó, Hungary

In the other 1.000 qm industrial workshop the Hungarian innovative SME POWER-ENERGY Ltd. has built-up the large-scale-size thermo-catalytic conversion technology prototype.
Today these prototypes will be transformed into for industrial use utilizable equipment in Fehérvárcsurgó.

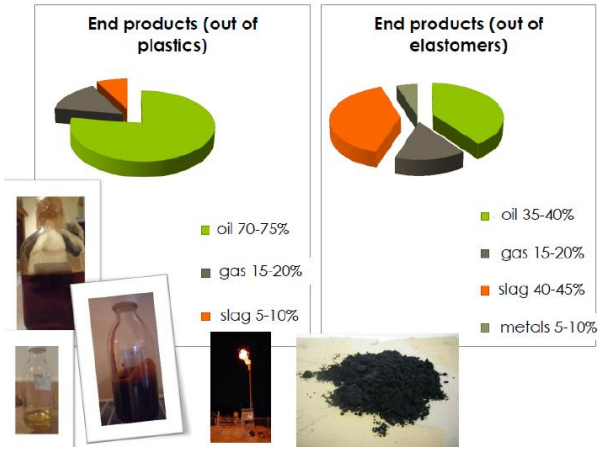

Figure 8. End-products of thermo-catalytic conversion as inputs of future developments

4. Future development plans

Domestic and international developments are running in more significant topics/directions. From one side it has to be enabled the material usage of today still for energetic recycling sorted mixed organic materials (mixed plastics and elastomer fractions). Probably will be a solution for this requirement the in the framework of previous W2Plastics project developed magneto-hydrostatic methodology. The unfilled, without fibre- and other reinforcement existing polyolefines (below 0,92 g/cm^3 density) are representing approximately 20 weight% from the total mixed plastics- and elastomers, so the material utilization of them seems not to be a too big challenge today, it can be done without bigger difficulties.
Grow of non-ferrous and precious metals prices as well as strategic valorisation of rear earth metals can intensify the R&D activity on the field of recycling of these elements. Continuous and rising need for those materials in the future electric-driven car-technology also increase the significance of that metals.
Special direction of research activity has to be defined for the recycling possibility of car-glasses which means in average 3 weight% in the todays personal cars. Problems are originated in the difference of front-glass with plastics layer for enlarge the traffic-safety to the rear window with built-in silver fibres for enabling dehumidification. Only the side-panel glasses are manufactured without adding any other substances. It means in the praxis, that the front-, side- and rear glasses has to be dismantled, threatened, and utilised in different material flows and processes, what naturally raise the costs of procedure. In addition to it, the economical process of these material-flows would need thousands of tons of that-type materials. Without that amount no Return Of Investment is calculated.

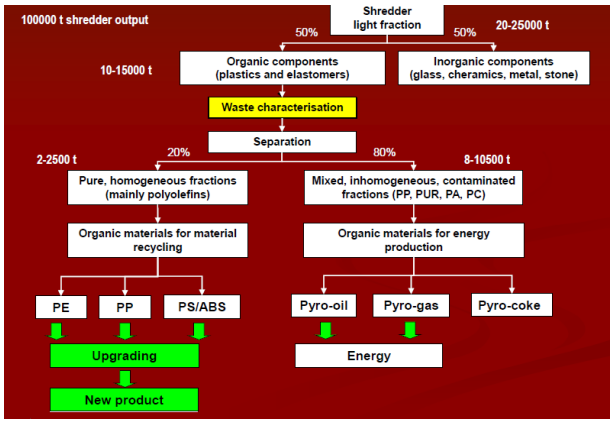

Figure 9. Further fields of development relating the material recycling

Big challenge is the utilization of fluff-products (dust-, foil- and sponge fractions) sorted by dry-cyclone technology of basic shredders. Just now it is much cheaper to landfill them as if it would start any R&D activity on that field. Preliminary tests have been done on the powder (dust) fraction, the measurements showed, that there are some ferrous-oxide (rust) content in it. Main question is again the economic operation possibility of any planned activity in recycling.

5. Conclusion

Recycling of End of Life Vehicles is a significant/very important task to save the World's raw material and mineral resources stocks. European Union and Hungary's law-makers has identified the sustainability and environmental protection issues and to solve them, they have created Directives regulating the material flow (take-over, collection, dismantling, preliminary treatment, process, utilization and landfill) of complex technical products (End of Life Vehicles, Wastes of Electric and Electronic Equipment, Rubber, Battery). Main task of those Directives is to introduce/steer the end of life products into the legal/permitted processing industry. Introduction of even growing, nearly 100% requirements for recycling ratio of individual material flows need new projects on this field. Process and utilization/recycling of today problematic materials has to be enabled by the future developments/new technologies.

Beside the tasks for economic operation are very important/significant the aspects of sustainability, life-cycle-assessment (LCA), rationality and naturally the environment protection too. These together influence the further development of legal- and research climate on this field.

Hungary is belonging in these procedures to the leading countries of EU, both with its R&D activity and generation of new development directions.

This only can guarantee the observance of 95 weight% recycling obligation with the 1. of January 2015.

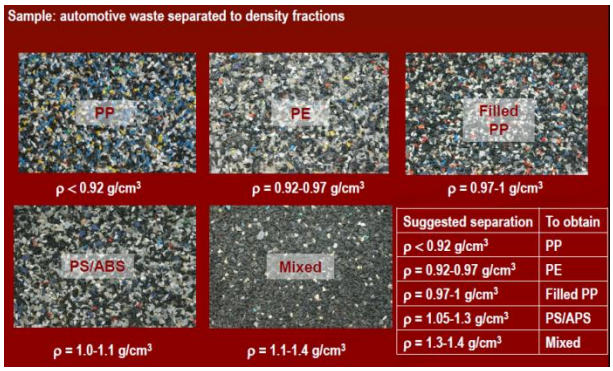

Figure 10. Suggested future separation of automotive shredding fractions for the material recycling

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ACCURACY IN THE GEOMETRICAL CHARACTERISTICS REDUCTION METHOD OF STEP SHAFT AT DEFLECTION COMPUTING

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Abstract
The contribution deals with the computing method of step shaft deflection in an intended place by using the diameter reduction method. This method is analytically studied on the selected shaft shape at different variants of diameters and individual span lengths, where values of deflection are compared with computed values without using of this reduction. These values were selected as exact, which was verified by numerical computing in PTC Creo Simulate software. In this contribution, the relative percentage errors are graphically interpreted, and it also deals with the creating of limiting conditions for its using. The aim is to point at limiting conditions of using this method, which may not be always met in practice. It also points to possible failures of this method, which is shown in an incorrect dimension of the shaft, influencing the reliability and safety of duty.

Keywords:
Deformation, relative percentage errors, shaft deflection, step shaft

1. Introduction

One of the basic tasks solved in elasticity and strength is to ask the question, how to compute dimensions of constructional components in order to reliably resist load during their duty. The aim is to exclude the possibility of arising limiting conditions, concretely losing of loading capacity, respectively hindering standard construction using, which is an excessive deflection.

In practice, we may encounter many cases, where deflection of individual component parts is more important for dimensioning than their strength. One of these components is a shaft, the basic component which enables rotational motion and torsion moment transferring [1]. When strength dimensioning, we get dimensions which pass a condition of strength, but deflection caused by outside load may be so high that it damages the other components of mechanism such as gears and bearings, where the shaft is their carrying element.

Moreover, in tooling applications, where we work accurately to hundredths of millimetres, this aspect cannot be ignored, because the shaft deflection has an effect on the position of cutting edges towards piece and so to tooling accuracy [2]. Also at the incorrect computed shaft deflection, the excessive vibrations and noise appear there. These vibrations can help to formation and extension of cracks which change the value of natural frequency [3]. These vibrations also have effects on buildings, machinery, equipment, and health and safety of people operating them [4]. Therefore, the control of deflection and deflection line slewing in defined places is important.

In the practical applications mostly the step shaft is appeared [5]. To compute its deformation, different methods are used, for instance Castigliano or Vereshchagin method, method of direct integration, moment area method, or initial parameters method [6] [7] [8]. When solving mechanics tasks, different numerical methods are also useful.

In literature we can find the method of diameter reduction as one of the form of computing simplification. This method is characterised by reduction of the individual diameters into one selected diameter, which markedly simplifies the task. This simplification may cause the great relative errors as a result of specific conditions infringement. In the contribution we will show different diameter and length variants of the specified shaft shape and deformation computing with and without using of reduction. The contribution will bring a list of conditions that allow to use the method of reduction, also with expressing of relative percentage errors at the computing model.

2. Method

The diameter reduction of the step shaft is one of the methods how a computing model can be simplified. This method is based on calculation of

the step shaft to the shaft with a uniform diameter, where changing of individual span lengths is caused. The step shaft was selected in a shape according to Figure 1.

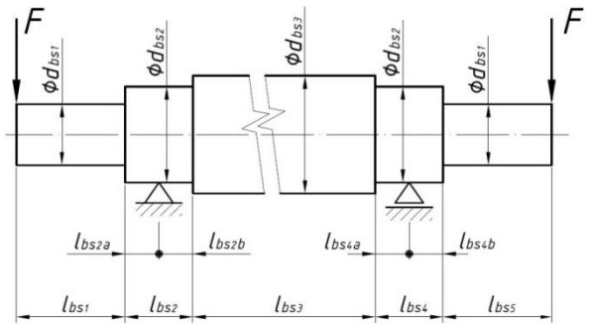

Figure 1. Computing scheme of the step shaft

The necessary condition is the keeping of equal value at the second derivation of deflection line function, where we rose from equation (1) for the selected section.

$$\frac{d^2 w_{(x)}}{dx^2} = \frac{M_{bs(x)}}{E \cdot J_{bs}} = \frac{M_{rp(x)}}{E \cdot J_{rp}} \text{ (m}^{-1}\text{)} \qquad (1)$$

$M_{bs(x)}$ – bending moment before reduction (N·m)
$M_{rp(x)}$ – bending moment after reduction (N·m)
J_{bs} – moment of inertia before reduction (m^4)
J_{rp} – moment of inertia after reduction (m^4)
E – modulus of elasticity (Pa)

By editing of equation (1) was derived the equation (2) used for editing of the individual section length.

$$l_{rp} = \sum_{i=1}^{n} l_{rpi} = \sum_{i=1}^{n} \left[l_{bsi} \cdot \left(\frac{d_{rp}}{d_{bsi}} \right)^4 \right] \text{(m)} \qquad (2)$$

l_{rp} – overall length of shaft after reduction (m)
l_{rpi} – length of i-th shaft section after reduction (m)
l_{bsi} – length of i-th shaft section before reduction (m)
d_{rp} – diameter of shaft after reduction (m)
d_{bsi} – diameter of i-th shaft section before reduction (m)

After reduction, the shaft had a shape according to Figure 2,

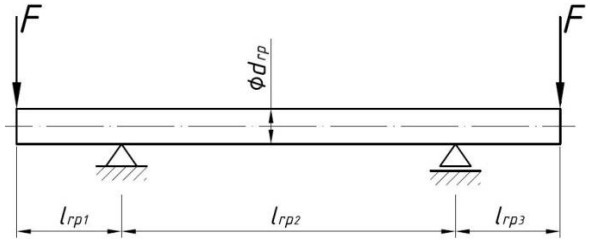

Figure 2. Shape of the reduced shaft

where deflection in the places of outside load action w_F may be computed from the equation (3)

$$w_F = \frac{F \cdot l_{rp1}^3}{3 \cdot E \cdot J_{rp}} + \frac{F \cdot l_{rp1}^2 \cdot l_{rp2}}{2 \cdot E \cdot J_{rp}} \text{ (m)} \qquad (3)$$

As it can be seen in the equation (3), the reduced length is in the shape of cube. This reduced length changes its value comparing to the primary length, depending upon diameter values. This value l_{rp1} after cube power causes an expressive increasing of deflection value w_F. It brings a question, how much a deflection w_F at reduction on different diameters d_{bs1}, d_{bs2} and d_{bs3} will be changed.
When computing deflection we used the graphic-analytical method so-called Vereshchagin method, where an effect of shearing force was taken into account. At properly chosen dimensions of the component, the curve radiuses of swings do not have a high effect on deformation and so they may be neglected [9]. The deflection equation (7) is derived from equations (4) – (6) which represent well-known Castigliano method.

$$w_i = \frac{\partial W}{\partial F_i} \text{ (m)} \qquad (4)$$

$$W = \frac{1}{2 \cdot E} \int_0^l \frac{M_{(x)}^2}{J_i} dx + \frac{\kappa}{2 \cdot G} \int_0^l \frac{T_{(x)}^2}{A_i} dx \text{ (J)} \qquad (5)$$

$$w_i = \frac{1}{E} \int_0^l \frac{M_{(x)}}{J_i} \cdot \frac{\partial M_{(x)}}{\partial F_i} dx + \frac{\kappa}{G} \int_0^l \frac{T_{(x)}}{A_i} \cdot \frac{\partial T_{(x)}}{\partial F_i} dx \text{ (m)} \qquad (6)$$

$$w_i = \sum_{i=1}^{n} \left(\frac{1}{E \cdot J_i} \cdot A_{Mi} \cdot m_{oTi} + \frac{\kappa}{G \cdot A_i} \cdot A_{Ti} \cdot m_{tTi} \right) \text{(m)} \qquad (7)$$

F_i – applied force in i-th place (N)
W – total strain energy of the shaft (J)
$M_{(x)}$ – bending moment (Nm)
J_i – moment of inertia of i-th section (m^4)
κ – Timoshenko coefficient for consideration of shearing force (-)
G – modulus of elasticity in shear (Pa)
$T_{(x)}$ – lateral force (N)
A_i – cross-section area in i-th cross-section (m^2)
A_{mi} – cross-section area under moment curve in i-th cross-section (Nm^2)
m_{oTi} – moment caused by unitary force in the place of centre of mass of i-th surface (m)
A_{Ti} – cross-section area under force curve in i-th cross-section (Nm)
m_{tTi} – shearing force caused by unitary force in the place of mass of i-th surface (-)

The values of deflection computed without using of reduction method was considered as exact. Then values of deflection were computed by PTC Creo Simulate software and compared to each other.
In comparison with deflection which is caused by outside load, many variants of diameters and lengths of individual shaft spans could be accomplished. Therefore, it was needed to introduce many limiting conditions. The shape of analysed shaft was designed on the basis of existing shafts, found in different applications of constructional practice. It consisted of five spans containing two overhanging ends and it was supported on two bearings. According to Figure 1

when taking shaft bearing into account, we considered with kinematics pair of pin and push fit. The limiting conditions were chosen as follows: $l_{bs1} = l_{bs5}$; $l_{bs2a} = l_{bs2b} = l_{bs4a} = l_{bs4b}$.
These conditions provide the existence of symmetrical shaft regarding dimensions and operated load. Out of this, it is clear that computing was sufficient to act in one plane and deflection was determined at only one overhanging end.
Dimensions d_{bs1}, d_{bs2}, d_{bs3}, l_{bs1}, l_{bs2}, l_{bs3} and force F were chosen on the basis of real parameters found in constructional practice. Overall, there were made six variants of computing. In the first three variants, for diameter d_{bs2} were chosen values according to made types of bearing namely 20, 40, and 60 mm. According to these dimensions we assigned values of length l_{bs2}, namely 12, 15, and 18 mm. At each dimension d_{bs2} there was made 121 variants, simultaneously the diameters d_{bs1} and d_{bs3} were changed, where conditions $d_{bs1} \leq d_{bs2}$ and $d_{bs2} \leq d_{bs3}$ were adhered. At each variant, there was step by step made reduction of shaft diameters on the basis d_{bs1}, d_{bs2} and d_{bs3}.
In the next three variants there were changed lengths l_{bs1}, l_{bs2} and l_{bs3} according to the rule of range adhering l_{bs1} = 50 ÷ 150 mm and l_{bs3} = 200 ÷ 400 mm, also diameters d_{bs1}, d_{bs2} and d_{bs3} were changed, length l_{bs2} was changed according to the previous case. From the obtained values relative percentages errors of individual methods are expressed and shown graphically on Figure 5 - 10. From these figures we created a set of assumptions presenting an obvious possibility of reduction in using on the individual base.

3. Results

After the substitution of chosen diameters and lengths of individual shaft span values into the equations (2), (3) and (7), concrete values of shaft deflections are obtained. After comparison of values according to the methods with and without reduction, the relative percentage errors representation are computed. Firstly, we computed by the numerical method that our exact values of deflection somewhat respond to analytical computing, which was shown by the values from PTC Creo Simulate software. The representation of relative percentage errors for individual variants is shown in Figure 3 and 4. It is obvious from this that the relative errors have values about tenths of percents, so it means the exact values are real. Figure 5 - 7 show dependence of the reduction method relative percentage errors at the bases d_{bs1}, d_{bs2} and d_{bs3} with using d_{bs2} = 20, 40 and 60 mm on the change of diameter d_{bs1} and d_{bs3}. Figures 8 - 10 show the logarithmic dependence of the reduction method relative percentage errors at the bases d_{bs1}, d_{bs2} and d_{bs3} for l_{bs2} = 12, 15 and 18 mm on the change of lengths l_{bs1} and l_{bs3}.

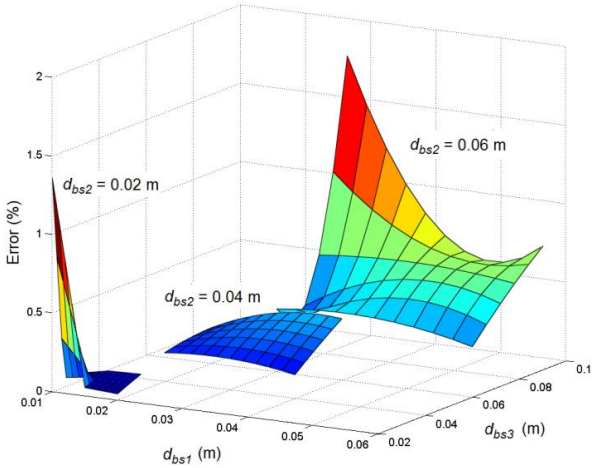

Figure 3. A dependence of numerical computing relative percentage errors for d_{bs2} = 20, 40 and 60 mm

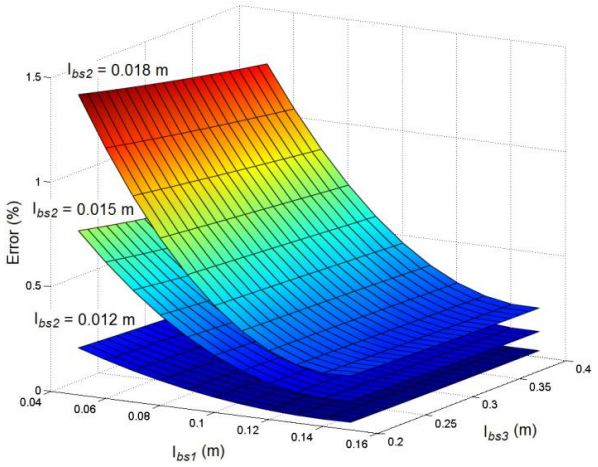

Figure 4. A dependence of numerical computing relative percentage errors for l_{bs2} = 12, 15 and 18 mm

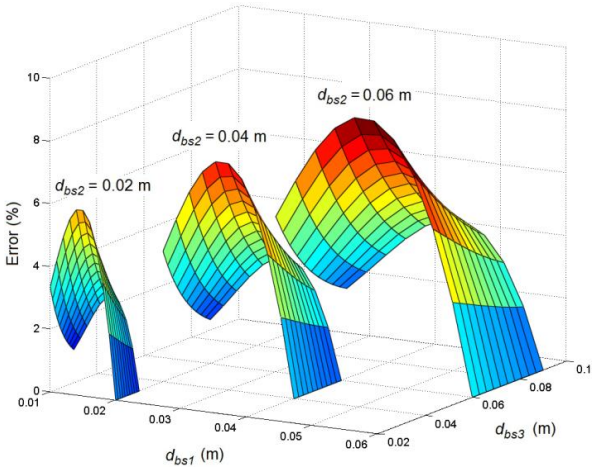

Figure 5. A dependence of the reduction method relative percentage errors at the base d_{bs1} for d_{bs2} = 20, 40 and 60 mm on the change of diameter d_{bs1} and d_{bs3}

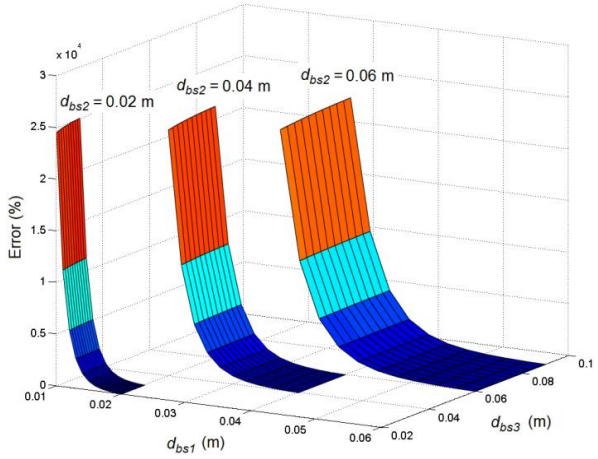

Figure 6. A dependence of the reduction method relative percentage errors at the base d_{bs2} for d_{bs2} = 20, 40 and 60 mm on the change of diameter d_{bs1} and d_{bs3}

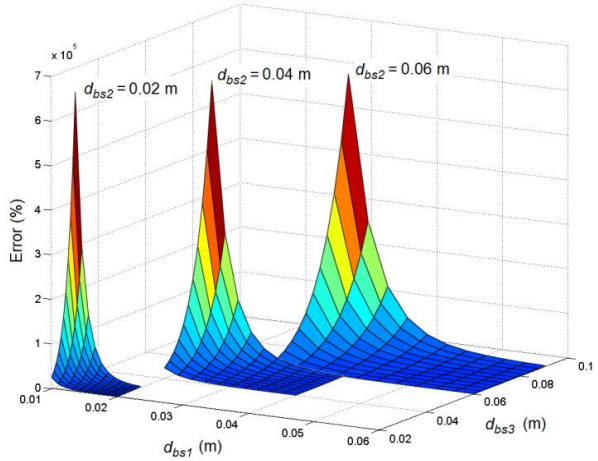

Figure 7. A dependence of the reduction method relative percentage errors at the base d_{bs3} for d_{bs2} = 20, 40 and 60 mm on the change of diameter d_{bs1} and d_{bs3}

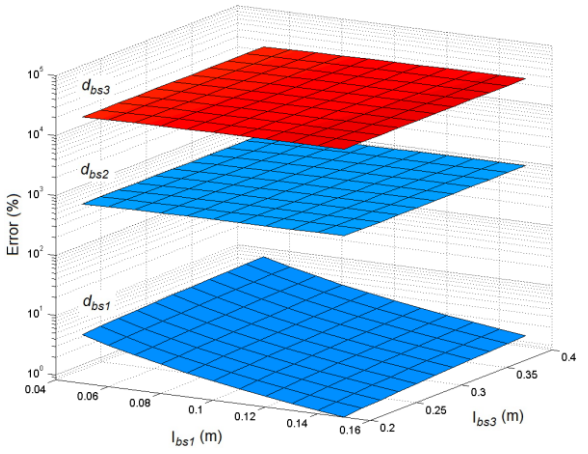

Figure 8. A logarithmic dependence of the reduction method relative percentage errors at the bases d_{bs1}, d_{bs2} and d_{bs3} for l_{bs2} = 12 mm

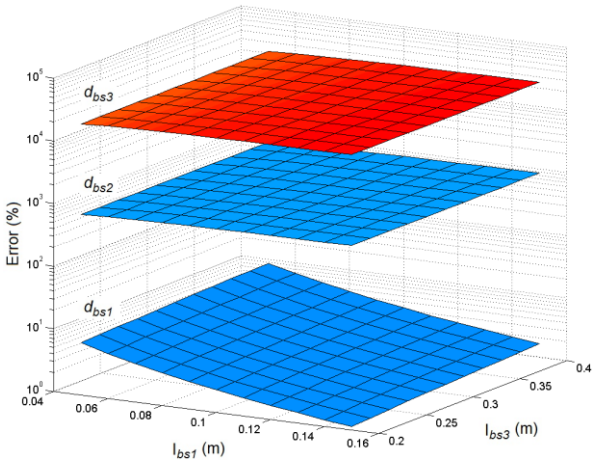

Figure 9. A logarithmic dependence of the reduction method relative percentage errors at the bases d_{bs1}, d_{bs2} and d_{bs3} for l_{bs2} = 15 mm

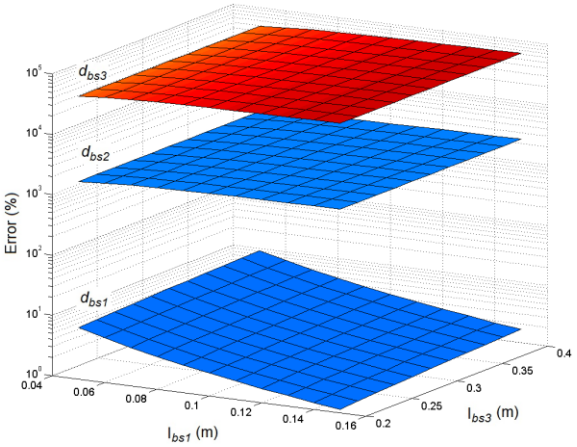

Figure 10. A logarithmic dependence of the reduction method relative percentage errors at the bases d_{bs1}, d_{bs2} and d_{bs3} for l_{bs2} = 18 mm

5. Discussion

Based on graphics outputs one may see that only at limiting condition the relative errors higher than 5% are committed. From Figure 5, where dependence of the relative percentage errors on a variability of the parameters d_{bs1} and d_{bs3} at different values d_{bs2} was rated, it follows that the relative error increases with decreasing dimensions d_{bs1}, but it decreases from a certain point again. With the increasing dimension d_{bs3}, the relative error decreases in the whole interval. At the chosen diameters d_{bs1}, d_{bs2}, d_{bs3}, l_{bs1}, l_{bs2} and l_{bs3}, did not exceed the relative error more than 9%. From this figure it can be seen that with increasing diameters values, relative error increases, with it relate ratios of diameters and lengths of individual spans, since these increase with widening diameters values. It follows from this that ratio proportions between diameters and lengths of individual spans have to be minimized.

From Figure 6, where the reduction of diameters on the base d_{bs2} was performed, follows that

relative error increases with decreasing diameter d_{bs1}. Also, this relative error increases with increasing diameter d_{bs3}, but this aspect is not statistically significant. The relative error, which is committed, is relatively high at very small differences of diameters, order of tens percent in dependence on individual geometrical parameters values. From Figure 7, where was performed the reduction of diameters on the base d_{bs3}, we got knowledge, that relative error increases with decreasing of diameter d_{bs1} and increasing of diameter d_{bs3}. Similarly, as at reduction on the base d_{bs2}, we commit relatively high relative errors, order of tens to thousands percent.

From Figure 8, 9, and 10 follows that at reduction of diameters on the base d_{bs1}, the relative error increases with decreasing of length l_{bs1}, also with increasing of length l_{bs3}, but not significantly. At reduction on the base d_{bs2}, respectively on d_{bs3}, the relative error decreases with decreasing of length l_{bs1} and increasing of length l_{bs3}. There is again applied the same rule as at results from Figure 5, 6, and 7. By the reduction on the base d_{bs1} we commit the relative errors order of percent, while at reduction on the bases d_{bs2} and d_{bs3} it is order of hundreds to thousands percent.

The next fact which was noticed, are values of deflections. At reduction of diameters on the base d_{bs1}, computed deflections are always smaller than deflections computed analytically. By reduction on the base d_{bs2} and d_{bs3}, the computed deflections are higher. In the first case (reduction on the base d_{bs1}), condition is undersized, in the second and third case condition is oversized.

Based on previous, next condition can be set and the relative errors may be eliminated. From the results it follows that the reduction of step shaft on the bases d_{bs2} and d_{bs3} is not a suitable for practical use. In practice it is hard to find the shaft whose dimensions parameters pass the condition of very small differences among diameters, what reductions on the bases d_{bs2} and d_{bs3} unconditionally require. At reduction on the base d_{bs1} the lowest relative errors are committed and in some cases theoretically acceptable. The lowest relative errors are achieved in the case of the highest or lowest differences among diameters and also length l_{bs1} should be much higher comparing to length l_{bs2}.

6. Conclusion

As it has been shown in this contribution, the method of step shaft reduction is inappropriate for computing of beam deformations and similar components in incorrect chosen process. In the contribution the step shaft consisting of five spans and contained three different diameters and lengths was analysed. By Vereshchagin method was computed the deflection in the concrete place at the ends of shaft, where this method was set as base of correct results. This theory was compared through PTC Creo Simulate software, where the individual variants of the shaft were simulated. The relative errors appeared between numerical and analytical computing are situated on the limit of tolerance 5% and it relates to computing algorithm of the software.

As it follows from the previous text, the unacceptability of the reduction diameter method was successfully verified in the case of non reduction on the lowest diameter because of relative errors which oversized 5%. In the case of reduction on the bases of higher diameters, at low differences among diameters we commit high relative errors, in case of difference 1 mm, the relative errors are order of tens percent and next increase. Relative errors will not appear only in the case of shaft with one diameter along its length, but there is not needed the method of reduction here.

Only one available variant is reduction on the base of the lowest diameter. In the individual cases there were not appeared relative errors over than 9%. If we want to minimize the relative errors, it is needed to set a condition, where this criterion is met. On the basis of the previous text and results we may say the hypothesis that the reduction of diameter is suitable for the shaft, where differences among individual diameters are significantly high and length of overhanging end is much higher than the length of the part under bearing.

At the time of finite element method using and especially computers using, the classical analytical methods of deformation computing recede into the background. In the consideration of this fact, we do not often meet with this method, respectively there exist other hand methods which are easier in their character, or they are quicker for computing. For this reason, there exist only a few literature sources which deal with it.

Because the dimensioning mistakes at this method using in practice applications and education process are known to us, we consider as important to remind of the limiting condition of its using, because of protection prior to fatal errors which would have negative impact on the safety and reliability of construction. Also we consider the different shaft design research as important.

Acknowledgement

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DIAGNOSTICS AND ANALYSIS OF THE INFLUENCE OF CRACKS ON THE INTEGRITY OF THE THICK-WALLED PRESSURE VESSELS

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Abstract
In order to achieve a more realistic assessment of the integrity and life of pressure vessels detailed diagnostics and analysis of the potential presence of cracks is necessary. Since the respective thick-walled pressure vessel has been made in one piece by the plastic processing methods and has been in operation for about 70 years, it was clear that the presence of cracks and other damage was inevitable. A particular problem could be the possibility of cracks present in the structure during operation. Cracks and other similar structural damages represent the most dangerous causes of stress concentrations, and are therefore the most important for the safety of pressure vessels. An analysis of the influence of cracks on the integrity of the thick-walled pressure vessel is made by usage of fracture mechanics parameters and other mechanical tests. One part of the large research is presented in this paper.

Keywords:
diagnostic, cracks, fracture mechanics, integrity, thick-wall pressure vessel.

1. Introduction

Cracks and other similar damage to structures represent the most dangerous causes of stress concentration, and are therefore the most important for the safety of the pressure vessel. To access the general analysis of the impact of construction defects it is necessary first to register their presence, position and size.
The possibility of detecting cracks is connected to technological capabilities of equipment for the tests, as well as restricted access to places that are potential sites of cracks.
With the size of the structure increases the potential possibility of cracks presence and other damages as well. Pressure vessels of the interest are thick-walled accumulator type of vessels. These are made by the pin forging method from a single piece (wall thickness cca. 94 mm, internal diameter d_u = 800 mm, height cca. 4000 mm) and are designed for a working pressure of 350 bar.
A total number of 30 vessels have been made, of which one has been used for detailed analysis. The vessels have been in use for about 70 years.

2. Method

A series of nondestructive testing is performed, such as visual inspection, magnetic testing, ultrasonic testing. After determining the presence and size of the cracks destructive tests and evaluation of integrity in terms of fracture mechanics were performed.
Potentially dangerous places are spotted with endoscopic examination of the connection point on the head bottom at the throat zone. Due to the unavailability of critical location, the subject vessel was parted in 6 parts for detailed analysis, and for the purpose of taking specimens for destructive tests.
On the inner inside of the vessel damages like cracks were observed, which could affect the integrity of the vessel. These defects were discovered on a parted vessel in the area of the throat at the bottom head and are clearly visible. Cracks emerge from the folds on the inner surface of the vessel, Figure 1. Cracks were observed on both sides of vessel, labeled as C1 and C2.

Figure 1. The crack in the throat zone at the bottom head - vessel segment C2

Maximum dimension of cracks are determined by magnetic and ultrasonic tests and are given in Table 1. On other segments of the vessel damages like cracks were not detected.

Table 1. Measured dimensions of the cracks

No.	Specimen identification	Depth, mm	Length, mm
1	C1	12.6	55
2	C1	5.4	27
3	C1	<1.0	160
4	C2	9.8	145
5	C2	3.4	90

All registered cracks have occurred in throat areas of the bottom head and haven't appeared elsewhere on the vessel.
In order to determine the cause of the visually perceived cracks of the sample excised from the air vessel, metallographic analysis was made. By visual examination of the sample two cracks are identified propagating from the inner corrugated wall of the vessel perpendicular to the folds of material that occurred during hot deformation of the vessel making process. Metallographic scrapings were taken at locations of visually observed cracks in two perpendicular directions.

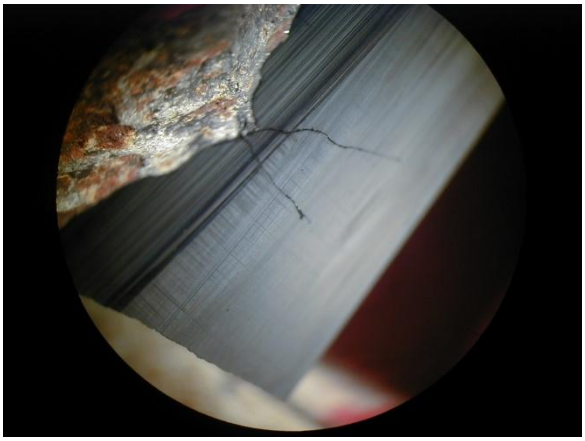

Figure 2. The crack from the top of the fold in the throat area

All analyzed cracks are of inter-granular stress type, followed by the oxide and numerous fine oxides. Around the cracks ferrite-pearlite microstructure of the vessel is decarburated, there is intense internal oxidation.
Metallographic footage of cracks and micro-structure around cracks are given at the Figures 3 and 4.
Metallographic analysis was conducted to determine the cause of the two visually observed cracks and showed: several parallel micro-cracks,
all cracks are of stress and intergranular type followed by intense oxidation and with decarburated ferrite-pearlite microstructure, cracks accompanied by such oxidation are associated with high temperatures and could only arise in the process of vessel manufacturing.
Stress-relief annealing, where the vessel was subjected to in order to release residual stresses, did not lead to changes in the microstructure of air vessels, nor could cause errors of this type. According to literature, the oxidation at high temperatures increases the abundance of elements that have a greater affinity for oxygen than iron, such as silicon and chrome.

Figure 3. Crack-decarburisation detail around crack (x75)

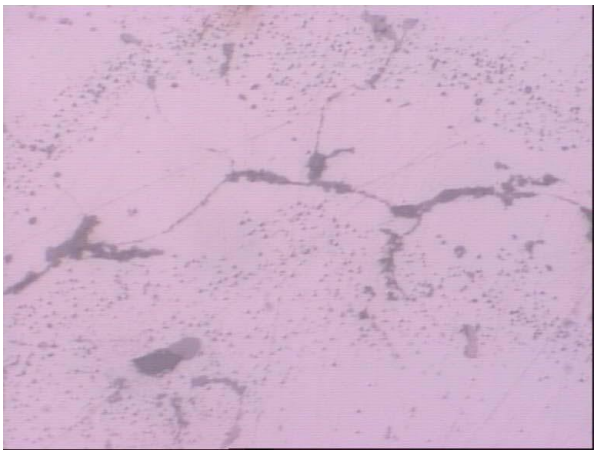

Figure 4. Perlite at grain boundaries (x725)

Series of specimens were taken from the central part of the cylindrical part of the vessel and from the area of the bottom head, with the aim of determining material properties, and analysis of long operation influence to the mechanical properties of materials.
The test program includes:
- determination of tensile properties;
- determination of impact properties;
- determination of the critical factor of stress intensity K_{Ic}, and the critical crack length a_c;
- determination of fatigue crack growth rate da/dN and fatigue treshold ΔK_{th}.

The body of the vessel is made of the steel 40Mn6 according to DIN standard marking. Thick-walled vessels are made by plastic deformation process. The compact part of forging from a central cylindrical part of the vessel with diameter

998∅/800∅mm and from the bottom head zone was taken for testing, Figure 5.

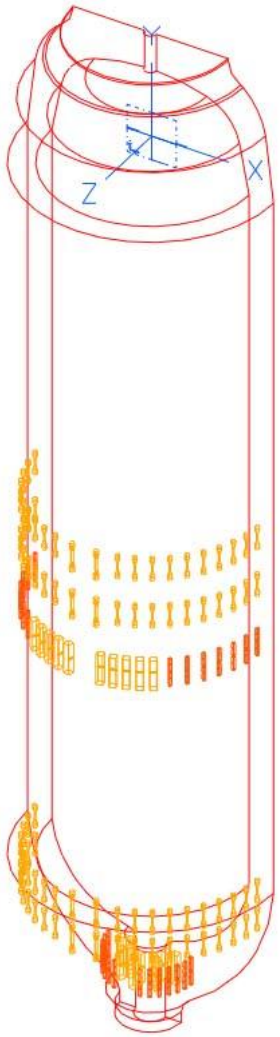

Figure 5. Direction of sampling

3. Results

Chemical composition of the vessel's material is defined as 40Mn6. The research was made from the submitted sample of material from which shavings for chemical analysis were extracted. The analysis was done by wet method (analytical), with the previous control analyzes done with quantometer. Results of the chemical composition determination are given in Table 2.

Table 2. Chemical composition of the vessel's material

Mark	Chemical element, %								
	C	Si	Mn	P	S	Cr	Mo	Ni	Cu
40 Mn 6	0.29	0.40	0.66	0.018	0.021	0.53	0.12	0.32	0.14

Typical stress-elongation diagram for samples from the middle of the vessel is shown in Figure 6.

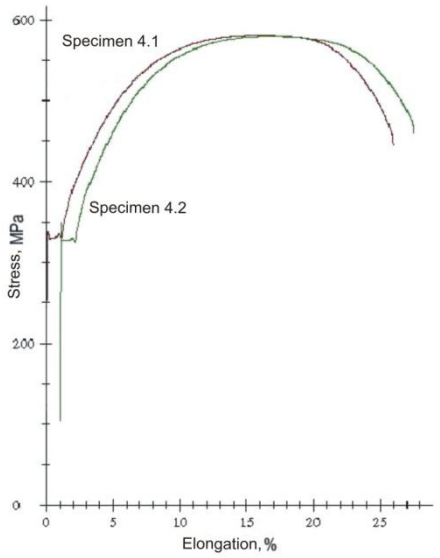

Figure 6. Diagram stress - elongation

Results of tensile test of specimens (mean values for the three samples) taken from the middle of the vessel and from the head are given in Table 3.

Table 3. Tensile testing results

Specimen place	Yield strength R_{eH},N/mm^2	Tensile strength R_m,N/mm^2	Elongation A, %	Constriction Z, %	Modulus of elasticity E, GPa
Middle	343.5	580.5	29.75	52.0	204.0
Head	325	587.5	24.75	37.5	204.0

Impact testing of samples was made at temperatures +20°C, 0° and - 20°C.
The test procedure was performed according to ASTM E 23-95 standard. Mean values of test results for three samples are given in Table 4.

Table 4. Results of impact testing

Sample mark	Temp. °C	Total impact energy, A_{uk}, J	Crack initiation energy, A_I, J	Crack propagation energy, A_P, J	Ductile fracture share %	Impact toughness J/cm^2
Middle	20	41.0	25.3	15.7	28.7	51.3
	0	30.9	22.4	8.52	18.6	38.7
	-20	23.2	20.1	3.15	10.8	29.1
Head	20	30.5	18.0	12.4	32.4	38.1
	0	20.5	14.0	6.53	15.1	25.7
	-20	18.4	17.0	1.34	7.80	22.9

A typical graph obtained by testing a specimen from the center of the vessel at +20°C is shown in Figure 7.

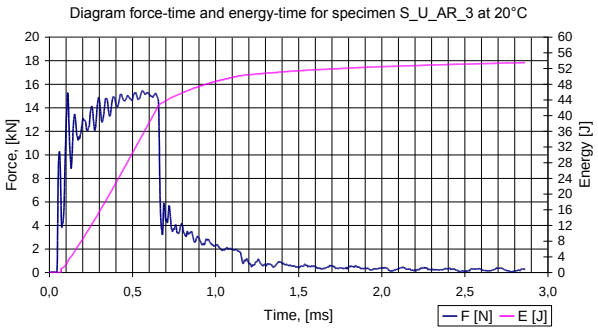

Figure 7. Diagram obtained by impact testing at +20°C

Experimental determination of J-integral and CTOD value was performed in accordance with standard ASTM - E 1820. The SENB type of the test specimen with dimensions 25x25x125 mm was used. Typical force-displacement plot for the samples from the middle of the vessel are shown in Figure 8.

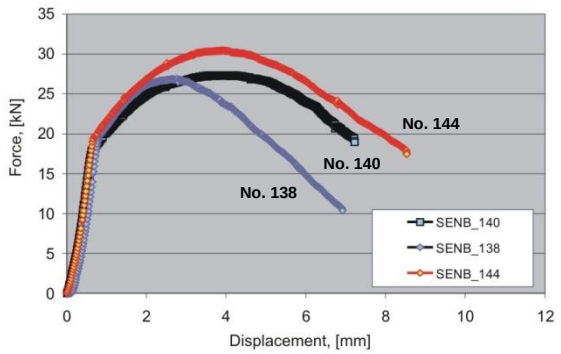

Figure 8. Force-displacement diagram

CTOD-R curves for samples from the middle of the vessel are shown in Figure 9.

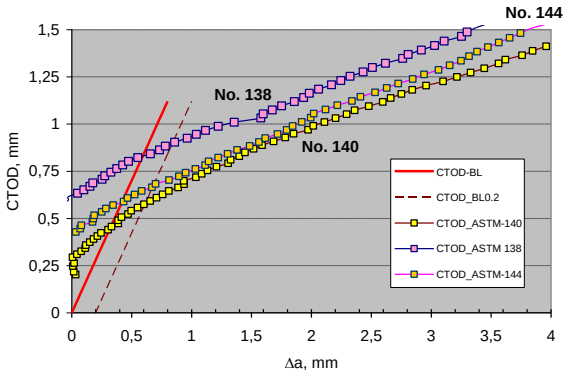

Figure 9. CTOD-R curve

As the demands for the fullfilment of plane strain conditions:

$$B \geq 2{,}5 \cdot \left(\frac{K_{Ic}}{R_T} \right)^2 \qquad (1)$$

are not met, instead of linear elastic- fracture mechanics applying, elastic-plastic fracture mechanics is used, also defined according to ASTM 1820-05. The aim of using elastic-plastic fracture mechanics is determined the value of the critical stress intensity factor, K_{Ic}, indirectly through the critical J integral, J_{Ic}, i.e. to monitor the development of cracks in the conditions of expressed plasticity. The calculated mean values of fracture toughness at plane deformation K_{Ic}, are given in Table 5.

Table 5. Measured and calculated values of CTOD fracture toughness at the stage of initiation and at max. force

Specimen place	Initiation			Max. force			
	$K_{I,i}$ MPa√m	$CTOD_i$ mm	F_i kN	$K_{I,max}$ MPa√m	$CTOD(\delta_5)$ mm	F_{max} kN	$CTOD_m$ mm
Middle	206.1	0.41	26.1	284.07	0.76	28.2	0.58
Head	126.9	0.16	21.6	180.2	0.35	24.7	0.28

After the experiment the re-fatigue process was carried out to mark a stable crack growth and definitive fracture of the specimen.
Obtained values of fracture toughness at plane deformation K_{Ic} for this group of materials are acceptable and classify subject steel into the

category of materials resistant to the presence of defects of crack type.
By applying the basic formula of fracture mechanics:

$$K_{Ic} = Y \cdot \sigma \cdot \sqrt{\pi \cdot a_c} \quad (2)$$

and entering values of yield strength for the material, $\sigma_{max}=R_{eH}$, assuming the shape factor Y=1,12 approximate values for the critical crack length, a_c, can be calculated according to the formula:

$$a_c = \frac{1}{\pi}\left(\frac{K_{Ic}}{Y \cdot \sigma_{max}}\right)^2 \quad (3)$$

Mean values of critical crack length for different test samples taken from the central part and from the head of the vessel are shown in Table 6.

Table 6. Critical crack length

Spec. place	Max. stress R_{eH} MPa	Critical stress intensity factor K_{Ic} MPa√m	Critical crack length a_c mm
Middle	343.5	206.1	91.4
Head	325	126.9	38.8

The ASTM E647 standard provides measurement of the rate of fatigue crack growth da/dN, which is developed from existing crack and calculation of the range for the stress intensity factor, ΔK. Tests for determining the rate of fatigue crack growth da/dN and the fatigue threshold ΔK_{th} are performed on standard Charpy specimens by bending the specimen at three points on the resonant high pulsator CRACKTRONIC. Measuring gauges (foils) RUMUL RMF A-5 with measuring length of 5 mm are placed on mechanically prepared specimens, for the purpose of crack growth measurement with the FRACTOMAT device.
For the analysis of this case with the range of the K-factor for which the gradient dK/da is to small, the model ΔK=const i.e. dK/da=0, is used, i.e. Paris' model:

$$\frac{da}{dN} = C \cdot (\Delta K)^m \quad (4)$$

where:
da/dN - crack growth rate,
C and m - constants obtained in the experimental tests,
ΔK - stress intensity factor range.

Relations log da/dN - log ΔK were calculated and plotted based on a series of tests. A typical diagram of relations da/dN of ΔK for the specimen from the middle of the vessel is shown in Figure 10.

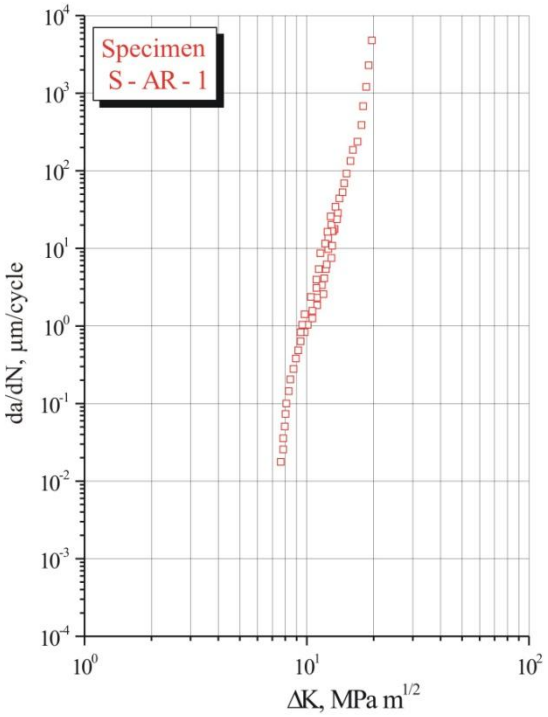

Figure 10. Diagram of relation da/dN - ΔK of the specimen from the vessel's central part

Coefficients in Paris equation determined from the diagram *da/dN - ΔK* are given in Table 7.

Table 7. Coefficients in Paris equation

Spec. place	Fatigue threshold ΔK_{th}, MPa $m^{1/2}$	Coeffic. C	Eksp. m
Middle	7.5	$4.13 \cdot 10^{-10}$	3.114
Head	7.3	$1.44 \cdot 10^{-10}$	3.824

For different values of the stress intensity factor ΔK the growth rate of fatigue crack initiation can be calculated, which for example for ΔK of 15 MPa√m has a value of 1.89 10^{-6} for the specimens from the middle of the vessel, or 4.53 10^{-6} m/cycle for specimens from the head zone, which is quite a large fatigue crack growth rate, and a high tendency to brittle fracture.
Fatigue threshold ΔK_{th} ranges from 7.5 for samples from the middle of the vessel, and 7.3 for samples from the head zone, which also represents a low value for this category of material.

4. Discussion

The existence of cracks and their dimensions has been determined by nondestructive testing. It was found that the cracks appeared during the drawing

due to the folding of the material, in the narrowing process (by compression) of the cylindrical portion of the vessel in the throat zone.
It was determined by destructive tests that the material 40Mn6, from which the vessel is made, had as follow:
tensile properties under the standard prescribed values for similar materials,
weak impact properties at room temperature,
a sudden drop of impact properties at temperature lowering,
sufficient fracture toughness but low resistance to stable crack growth,
high growth rate of fatigue cracks, and
weak resistance to the presence of cracks in the operation with variable loads.

5. Conclusion

It is evident that the permissible stress, which is lower than the conventional yield strength, would give higher values for critical crack length. This means that the test material may have a crack during the service time to the stated length, without danger of brittle fracture. Therefore, in order to detect crack securely before they reach a critical length, the advantage of suitable non-destructive methods should be taken, especially bearing in mind that the thickness of the material of high-pressure vessels that they are made of is greater than the critical length of the crack. It is important to note that the calculated value of the critical length of the crack, a_c, refers to the plane strain conditions and construction of finite thickness, and that each individual case must be corrected with respect to the actual thickness of the material of the construction.

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MEASURING BY USING 3D CONTROL EQUIPMENT

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Abstract
This paper deals with the description of the techniques of 3D control machined parts with associated equipment, software and devices that are used in the measurement procedure. 3D coordinate measuring device measures the dimensions of the part, but also the angles, the shape, the mutual position of surfaces and holes. Allows complex measurements with one positioning of the product on the measuring table, that avoids errors of positioning. The paper also presents an example of the measurement device for 3D control DEA GLOBAL Advantage ACTIV ®, and presents the results processed by software that is used by the same device.

Keywords:
dimensions, machining, measuring 3D control

1. Introduction

3D control technick starts to develop at the middle of 50th years last century as an reply on demands of control dimension accuracy of increasingly complex products, but also as reduction of production time, that finaly results with the lower selling price.
Besides making it easier to control the dimensions, the technique also reduces the time of measurement and control and almost completely reduces the occurrence of errors during the control dimension.

2. Main working principe

Main princip of work of this device is to recognize the coordinates of some points, lines, arcs and surfaces. According to this an numerical picture of measuring object has been. Schedule and number of measuring points on the surfaces of the measured object depends on shape and position of the surface and the required measurement accuracy. The minimum number of points is determined by mathematical laws that define the numerical image area: for a line at least two points, for circle three, for surface three collinear points. Accurate shape and position always gets on the basis of a larger number of measuring points.
The start and end point of measurement shall be determined by a certain amount of deflection of the stylus in two ways:

- The contact probe, by switches
- Touch Probe; measuring the difference in inductive voltage

The measurement results are read on a monitor or printed on a printer. The probe head of coordinate measuring machines contains induction sensor and touch probe. The primary function of the induction sensor is to place or cancel the electromotive force in the current round between touch probe and measuring object.

3. Description of 3D measurement device

In 3D control different machines and devices are used. The main parts of measuring devices are:
Surface for measuring – also shawn at figure 1. Is a surface for placing the measuring object, and is made from granit,
Probe head with touch (figure 2.),
Device for replacing probe touch (figure 3.),
reference sphere that is used to calibrate the machine (figure 4.),and
control unit for manual control of the machine (figure 5.).

Figure 1. The measuring device DEA GLOBAL Advantage ACTIV®

Figure 2. Probe head with touch

Figure 3. Device for replacing probe touch

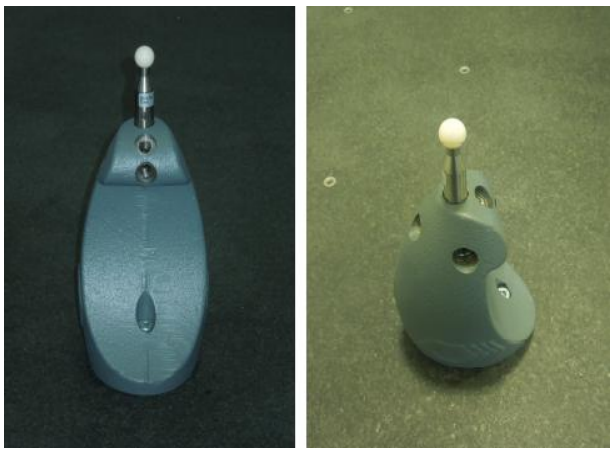


Figure 4. Reference sphere that is used to calibrate the machine

DEA GLOBAL Advantage ACTIV® uses software called Metrolog XG. The program is made by hand using a control unit for manual control of the machine (figure 5.) and is stored on the computer in the form of program. Programs can be revised as necessary and customize to the pieces to have to be controlled.

To create a program so-called. reference pieces are used. These are pieces that are dimensionaly closest to the drawings and to serve as a template for the program. They are marked with a special number or color such is green.

Figure 5. Control unit for manual control of the machine

Figure 6. Reference pieces marked with green color

Figure 7. Reference piece marked with number

Not more important for measuring is temperature.

DEA GLOBAL Advantage ACTIV® works on temperature between 10 and 45 degrees of Centigrade. Standardized measurement range at which achieve the most precise measurement is ~ 20 ° C, each degree above this temperature increases survey for approx. 2μm which can ultimately result in an incorrect result. There are also certain requirements on air quality, which means the moisture content and purity.

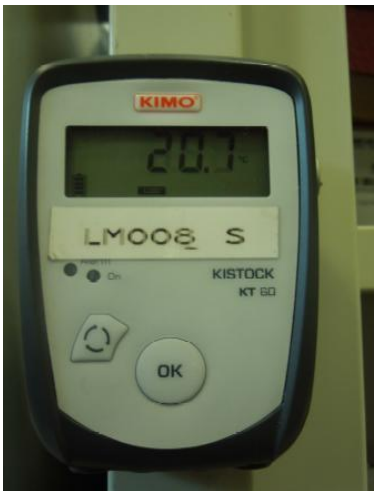


Figure 8. The temperature controlling device in a measurement room

4. Example of measurement

The measurement of the device is performed on the principle of preset programs which are loaded with a nominal measures according to drawings. The program is made manually for each new piece and is stored in the computer where it can be used or modify as needed. There are characteristic values that are measured for each piece (diameter, distances between the surface, etc.), they can be specify by the customer or the company itself (producer).

The program is developed in a way that with using a hand control characteristic points are determine, lines and curves on the reference model and the coordinates of each point along the curves and distances between them are stored in the program. The device DEA GLOBAL Advantage ACTIV® uses software called Metrology XG. Figure 9 shows the interface means of which the program for controlling the dimensional accuracy works.

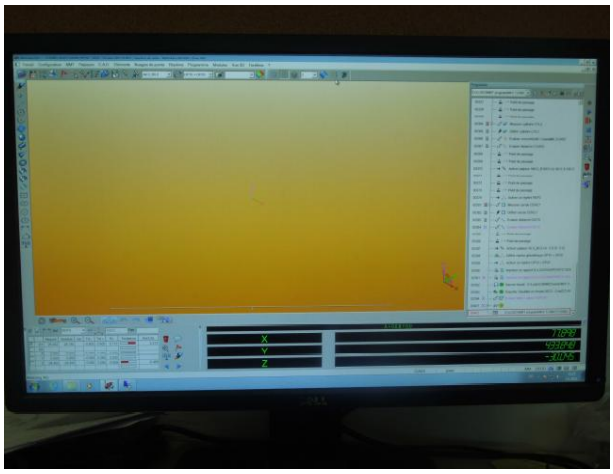


Figure 9. interface program Metrology XG

Figure 10. shows the detail interface depicting the lines, curves and angles that are used when creating the program for the control of dimensional accuracy.

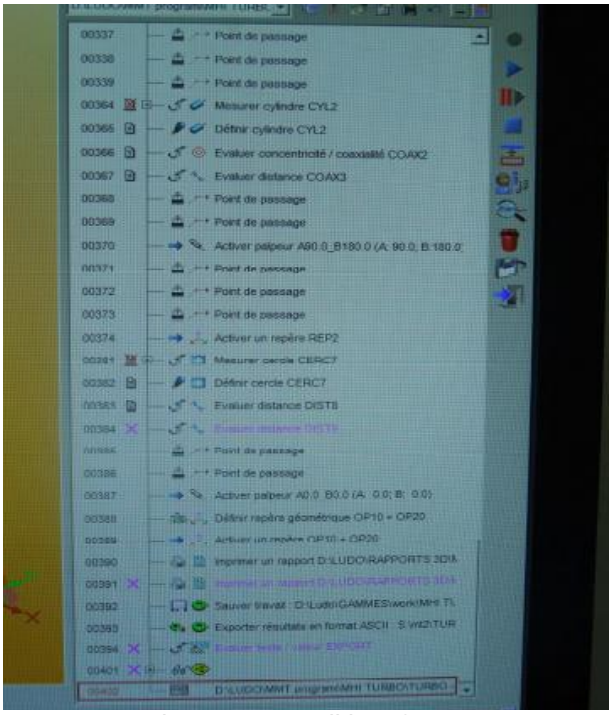


Figure 10. Detail interfaces

Before the measurements of the new pieces the same shall be placed on the measuring surface and held in place with the clamping device (Figure 11). Each device has a shape that corresponds to the measured piece to avoid mistakes during clamping. There are also clamping devices for clamping of the pieces from series and the measurement of different positions allowing smaller number of devices which saves storage space, as well as the price of making devices.

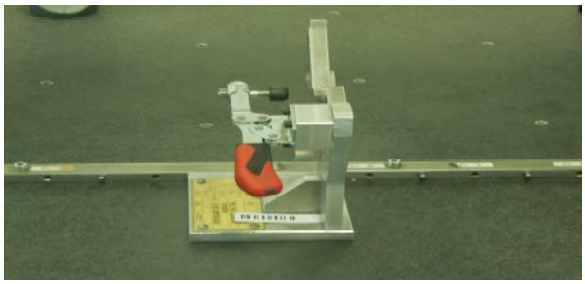
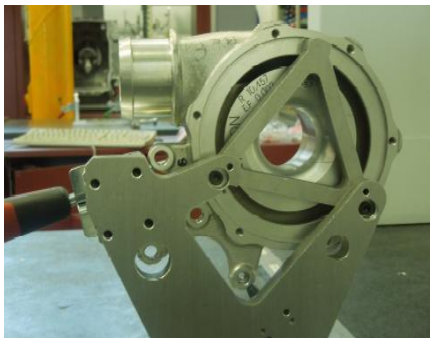


Figure 11. Clamping device

At Figure 12. a) and b) there is shawn a piece clamped in a clamping device and ready for measuring.



a)

b)

Figure 12. a) and b) Measured piece in clamping device

The measured value is obtained as follows:
Touch Probe based on a program measures the given number of points (in this case 8) and based on the linear interpolation performed by the program comes to a final measured quantity which is compared with that of the given program and determine whether there is a deviation or not.
Figure 13 shows a princip of measuring roundness.

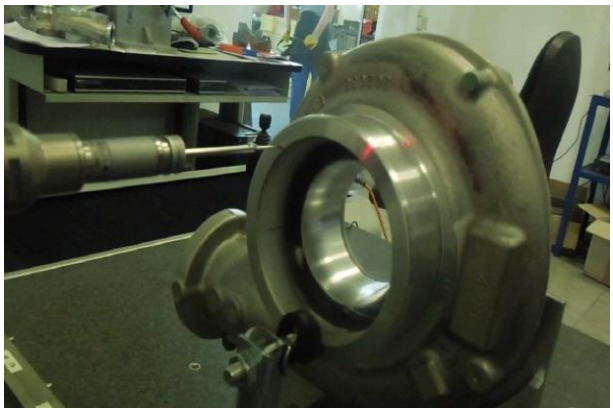


Figure 13. Measurement of roundness

When measuring the diameter (figure 14.) the principle is the same as for measuring roundness: probe measured a certain number of points whose number depends on the size of the diameter of the pieces and linear interpolation comes to the actual extent of pieces whose value is compared with the nominal value given in the program.

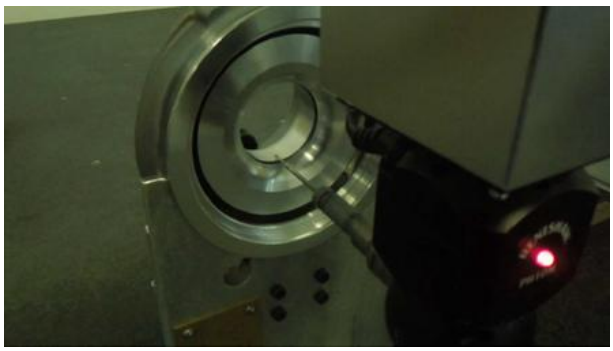


Figure 14. Measuring of the diameter

Measured results from the program are stored in a table in pdf format (figure 15) for easier reference, and printing options. The table should contain the following information:
REFER.- reference name of the position is unambiguously identified for each position to aid in identification
NOMINAL- nominal size, the default drawing
MESURE- measured value
TOL- -lower tolerance limit
TOL+ - upper tolerance limit
ECART- difference between nominal and measured value
TENDANCE - tendency, whether it goes to the lower or upper olimit of the permitted tolerance

There is also the ability to export data in a variety of software who may use this information for various analyzes, production monitoring, statistics and so on.

RESULTATS

REFER.	NOMINAL	MESURE	TOL-	TOL+	ECART	TENDANCE
PLTE1	Planéité PLANEITE DE 0.1 PAR BOSSAGE					
	PLAN 0.000	0.003		0.100	0.003	
PLTE2	Planéité PLANEITE DE 0.1 PAR BOSSAGE					
	PLAN 0.000	0.001		0.100	0.001	
PLTE3	Planéité PLANEITE DE 0.1 PAR BOSSAGE					
	PLAN 0.000	0.001		0.100	0.001	
CERC3	Cercle Ø 13.3 H10					
	DIAM 13.300	13.336	0.000	0.070	0.036	
	E.F.	0.006			0.006	
CERC4	Cercle Ø 10.7 0/+0.7					
	DIAM 10.700	10.801	0.000	0.700	0.101	
	E.F.	0.002			0.002	
COAX1	Coaxialité CONCENTRICITE Ø 10.7 / A					
	COAX 0.000	0.009		0.200	0.009	
CERC5	Cercle Ø 13.3 H10					
	DIAM 13.300	13.338	0.000	0.070	0.038	
	E.F.	0.004			0.004	
CERC6	Cercle Ø 10.7 0/+0.7					
	DIAM 10.700	10.792	0.000	0.700	0.092	
	E.F.	0.002			0.002	
COAX2	Coaxialité CONCENTRICITE Ø 10.7 / B					
	COAX 0.000	0.009		0.200	0.009	
DIST1	Distance ENTRAXES DES 2 DIAMETRES 13.3 H10					
	X -85.500	-85.482	-0.050	0.050	0.018	
	Y -26.400	-26.394	-0.050	0.050	0.006	
LOCA1	Localis. LOCALISATION Ø 13.3 H10					
	LOCA 0.000	0.039		0.100	0.039	
CERC7	Cercle Ø 10.7 0/+0.7					
	DIAM 10.700	10.791	-0.000	0.700	0.091	
	E.F.	0.004			0.004	
DIST2	Distance POSITION Ø 10.7 JS13					
	X -79.000	-78.999	-0.100	0.100	0.001	
	Y 17.500	17.485	-0.100	0.100	-0.015	
LOCA2	Localis. LOCALISATION Ø 10.7 JS13					
	LOCA 0.000	0.030		0.200	0.030	
PLTE4	Planéité PLANEITE BOSSAGE BRUT					
	PLAN 0.000	0.052		0.300	0.052	
PARA1	Parallél. PARRALLELISME BOSSAGE BRUT					
	PARA 0.000	0.088		0.300	0.088	
DIST5	Distance EPAISSEUR BOSSAGE					
	D1 10.000	10.014	-0.700	0.700	0.014	
	D2 10.000	9.926	-0.700	0.700	-0.074	
PLTE5	Planéité PLANEITE BOSSAGE BRUT					
	PLAN 0.000	0.007		0.300	0.007	
PARA2	Parallél. PARRALLELISME BOSSAGE BRUT					
	PARA 0.000	0.091		0.300	0.091	
DIST6	Distance EPAISSEUR BOSSAGE					
	D1 10.000	10.136	-0.700	0.700	0.136	
	D2 10.000	10.045	-0.700	0.700	0.045	
PLTE6	Planéité PLANEITE BOSSAGE BRUT					
	PLAN 0.000	0.025		0.300	0.025	
PARA3	Parallél. PARRALLELISME BOSSAGE BRUT					
	PARA 0.000	0.106		0.300	0.106	
DIST7	Distance EPAISSEUR BOSSAGE					
	D1 10.000	10.367	-0.700	0.700	0.367	
	D2 10.000	10.261	-0.700	0.700	0.261	
PARA15	Parallél. PARALLELISME PLAN BRUT DURITE					
	PARA 0.000	0.037		0.300	0.037	
ANGL2	Angle ANGLE DE LA DURITE					
	ESP -33.400	-33.304	-0.500	0.500	0.096	
DIST3	Distance POSITION DURITE COTE DE 35.5 ±0.4					
	X -35.500	-35.254	-0.400	0.400	0.246	
DIST4	Distance POSITION DURITE DE 8.3 ±0.4					
	D1 8.300	7.897	-0.400	0.400	-0.403	-0.003

Figure 15. Measuring results

5. Conclusion

On the basis of data on this type of control can be concluded that the 3D coordinate measuring devices improve quality control, reduce measurement time and allow for a wide range of measured quantities that would be difficult to measure by hand. Also, the occurrence of errors in the measurement by using 3D control device is reduced to a minimum.

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THERMAL MODELLING AND ANALYSIS OF FSW: A REVIEW

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Abstract
Friction Stir Welding (FSW) is an emerging solid-state joining technology that is being developed since last two decades. This new technique is presently being successfully applied in various industrial applications i.e. aerospace, automobile, ship building etc. The aim of this review paper is to exhibit and focus previous research, similar or related to this topic carried out by various researchers and also to develop a basic understanding to Friction Stir Welding process. In the last decade a dependable work has been perform on the numerical simulation of FSW in order to improve a proper numerical model able to support the design process. Two main methodologies were considered during this period, namely the use of analytical models, reproducing the thermal flux generated during the process, and of thermo-mechanical simulations through FE models. This present review paper also provides a basis for the industrial practitioners and researchers to search further new alternatives regarding the thermal modelling and analysis of FSW.

Keywords:
Friction Stir Welding (FSW), Solid state joining, numerical simulation, FE models, Thermal modelling.

1. Introduction

Friction stir welding (FSW) is a new solid-state joining technology invented at the welding institute (TWI) in 1991 [1]. The basic concept of FSW is remarkably simple. A non-consumable rotating tool with a specially designed pin and shoulder is inserted into the abutting edges of sheets or plates to be joined and traversed along the line of joint (Fig. 1).

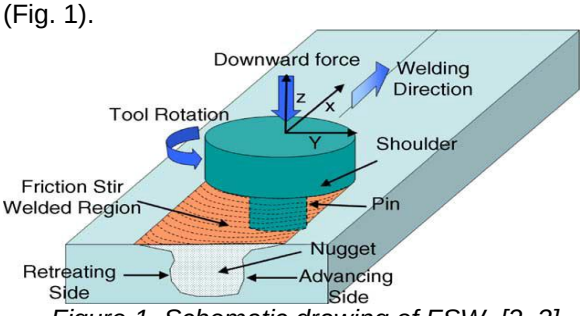

Figure 1. Schematic drawing of FSW. [2, 3]

The tool serves two primary functions: (a) heating of workpiece, and (b) movement of material to produce the joint. The heating is accomplished by friction between the tool and the workpiece and plastic deformation of workpiece. The localized heating softens the material around the pin and combination of tool rotation and translation leads to movement of material from the front of the pin to the back of the pin. As a result of this process a joint is produced in 'solid state'. Because of various geometrical features of the tool, the material movement around the pin can be quite complex [2, 3]. FSW is considered to be the most significant development in metal joining in a decade and is a ''green'' technology due to its energy efficiency, environment friendliness, and versatility [3]. The heat transfer process is one of the most important aspects in the FSW study. A good understanding of the heat transfer process in the workpiece can be helpful in predicting the thermal cycles in the welding workpiece, and the hardness in the weld zone, subsequently, can be helpful in evaluating the weld quality. A known temperature distribution is also important for calculating the temperature-dependent viscosity when modelling material flow [4].

H.B. Schmidt et. al. (2008) in their work presented the basic elements of the thermal modelling of friction stir welding as well as to clarify some of the uncertainties in the literature regarding the different contributions to the heat generation. Some of their results from a new thermal pseudo mechanical model in which the temperature-dependent yield stress of the weld material controls the heat generation were also presented. Generally in all thermal models of FSW the main task is to solve the heat conduction equation with an appropriate set of initial and boundary conditions, i.e.

$$\rho c_p \dot{T} + u_i \rho c_p T_i = (kT_i)_i + \frac{Q_{gen}}{V} \qquad (1)$$

where Q_{gen}/V is the volumetric heat source term (W m^{-3}) arising from plastic dissipation. In their present work, the heat generation from both frictional and plastic dissipation was modelled via a surface flux boundary condition at the tool/matrix interface. The generally adopted equation for the total heat generation was:

$$Q_{total} = \delta Q_{sticking} + (1-\delta)Q_{sliding} = \frac{2}{3}\pi\omega\left[\delta\tau_{yield} + (1-\delta)\mu p\right]\left[\left(R_{shoulder}^3 - R_{probe}^3\right)(1-tan\,\alpha) + R_{probe}^3 + 3R_{probe}^2 H\right] \quad (2)$$

where δ is the contact state variable (dimensionless slip rate), τ_{yield} is the material yield stress at the welding temperature, μ is the friction coefficient, p is the uniform pressure at the contact interface, ω is the angular rotation speed, α is the cone angle, $R_{shoulder}$ is the shoulder radius, R_{probe} is the probe radius and H_{probe} is the probe height. However, when implementing this into a numerical model using a position-dependent surface flux (W m^{-2}), it was typically used in the following form

$$q_{total} = \dot{\gamma}\tau_{friction} + (\omega r - \dot{\gamma})\tau_{yield} = \omega r[\delta\tau_{yield} + (1-\delta)\mu p] \quad (3)$$

which in fact was the basis for deriving Eq.(2). Furthermore, when combining Eqs. (2) and (3) and assuming the simple tool geometry of a flat shoulder only, one obtains the following well-known expression for the heat generation (W m^{-2})

$$q_{total} = \frac{3Q_{total}\,r}{2\pi R_{shoulder}^3} \quad (4)$$

it can be applied as a radius-dependent surface flux in the model, under the assumption of a constant contact condition close to sliding or in cases of sticking where the shear layer is very thin. [5]

Vijay Shivaji Gadakh et al. (2013) developed an analytical model for heat generation for friction stir welding using taper cylindrical pin profile. The proposed analytical expression was the modification of previous analytical models known from the literature which was verified and well matches with the model developed by previous researchers. The results of the proposed model were validated with the data from previous researchers. Fig. 2 shows three different regions where Q_1 is the heat generated under the tool shoulder, Q_2 at the tool pin side and Q_3 at the tool pin tip, hence the total heat generation, $Q_{total} = Q_1 + Q_2 + Q_3$. Some assumptions made for their analytical modelling were as follows:

- The analytical estimation was based on a general assumption of uniform contact shear stress $\tau_{contact}$.
- In the sliding condition the shearing take place at the contact interface.

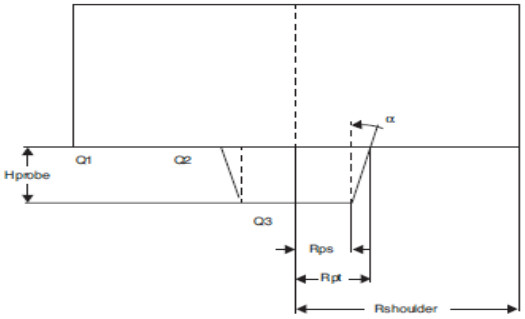

Figure 2. Different heat generated regions (Vijay Shivaji Gadakh et. al.2013)

- Other mechanism of heat generation such as deformation was not considered by them.
- Due to friction interface conditions the frictional shear stress $\tau_{friction}$ was considered. The shear stress estimated for a sliding condition was $\tau_{contact} = \tau_{friction} = \mu p = \mu\sigma$

The TC pin surface is characterized by the taper angle α. The general equation for heat generation can be written as:

$$dQ = \omega.dM = \omega.r.dF = \omega.r.\tau_{contact}.dA \quad (5)$$

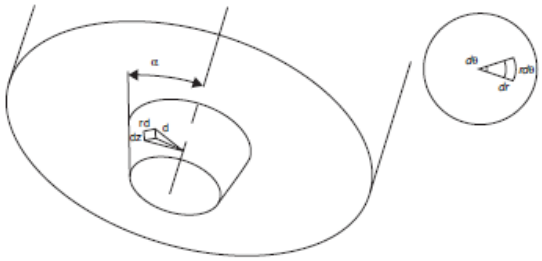

Figure 3. Surface orientations and infinitesimal segment areas for TC pin profile. (Vijay Shivaji Gadakh et. al.2013)

The heat generation from this infinitesimal segment is given by

$$dQ = \omega.r.dF = \omega.r^2.\tau_{contact}.d\theta.dr \quad (6)$$

where r is the distance from the considered area to the center of rotation, ω is the angular velocity, and r.dθ and dr are the segment dimensions.

The equation for heat generation from the shoulder surface can finally be written as:

$$Q_1 = \frac{2}{3}\pi\omega\tau_{contact}(R_{shoulder}^3 - R_{PT}^3) \quad (7)$$

The probe consists of a taper cylindrical surface with a bottom radius of $R_{PS,}$ top radius R_{PT} and probe height $H_{probe.}$ The equation for heat generation from the taper probe surface can finally be written as:

$$Q_2 = \frac{\pi.\omega.\tau_{contact}}{2}.\frac{H_{probe}}{cos\alpha}.(R_{PS} + R_{PT})^2 \quad (8)$$

The equation for heat generation from the pin tip surface can finally be written as:

$$Q_3 = \frac{2}{3}\pi.\omega.\tau_{contact}.R_{PS}^3 \quad (9)$$

From Eqs. (7) – (9), Q_{Total} can be calculated as: $Q_{Total} = Q_1 + Q_2 + Q_3$

But, $R_{PS} = R_{PT} - H_{probe} \cdot \tan\alpha$ (10)

Hence finally Q_{Total} can be written as:

$$Q_{Total} = \frac{2}{3}\pi\omega\tau_{contact}.\Big(R_{shoulder}^3 - R_{PT}^3 + \frac{3}{4}.\frac{H_{probe}}{cos\alpha}.\big(2.R_{PT} - H_{probe}.tan\,\alpha\big)^2 + \big(R_{PT} - H_{probe}.tan\,\alpha\big)^3\Big) \quad (11)$$

The energy per unit length of the weld can be calculated dividing Eq. (11) by the transverse speed:

$$Q_{Energy/length} = \frac{2}{3}.\frac{\omega.F.\mu}{v.R_{shoulder}^2}.\Big(R_{shoulder}^3 - R_{PT}^3 + \frac{3}{4}.\frac{H_{probe}}{cos\alpha}.\big(2.R_{PT} - H_{probe}.tan\,\alpha\big)^2 + \big(R_{PT} - H_{probe}.tan\,\alpha\big)^3\Big) \quad (12)$$

The effective energy per weld length (Q_{Eff}) is defined as the energy per weld length multiplied by the transfer efficiency (β, ratio of the pin length H_{Probe} to the work piece thickness t) and given by:

$$Q_{Eff} = \frac{h}{t}.Q_{Energy/length} = \beta.Q_{Energy/length} \quad (13)$$

For validation of their proposed model, the empirical relationship developed by Hamilton et al. [6] between the temperature ratio and the effective energy level was considered. The empirical formula is given by

$$\frac{T_{max}}{T_s} = 1.56X10^{-4}XQ_{Eff} + 0.54 \quad (14)$$

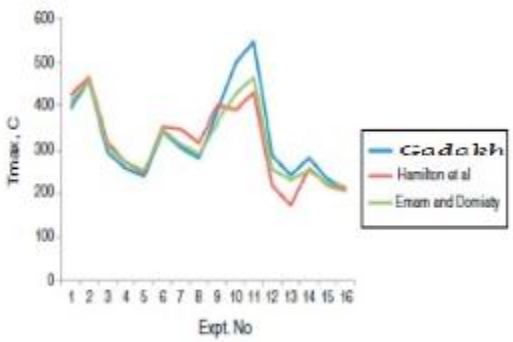

Figure 4. Variation of the peak temperature for the proposed model, Hamilton et al. [6] model and Emam and Domiaty [7] results.

From the obtained results, it was observed that less temperature is generated using taper cylindrical pin profile than straight cylindrical pin profile under given set of working conditions. Furthermore, numerical simulation result shows that increasing the taper pin angle leads to decrease in peak temperature [8].

Jabbari (2014) developed a thermal model used to simulate the friction stir welding of pure copper plates with the thickness of 4 mm in the constant traverse speed of 25 mm/min and five different rotation speeds. The heat flux in FSW is primarily generated by the friction and the deformation process. Thus, the governing equation for heat transfer in FSW was given by:

$$\rho c_p \dot{T} + Q = \nabla.k\nabla.T \quad (15)$$

where Q is the volumetric heat source term arising from plastic dissipation (W/m^3), ρ is the density of materials, c_p is the mass-specific heat capacity, k is the coefficient of thermal conductivity, T is the temperature, and $\nabla(= i\frac{\partial}{\partial x} + j\frac{\partial}{\partial y} + k\frac{\partial}{\partial z})$ is the gradient operator. In his work Jabbari (2014) presented a different approach that uses a moving coordinate system that was fixed at the tool axis. To simplify the model, the coordinate transformation assumes that the copper plates were infinitely long see Fig. 5. This means that the analysis neglects effects near the edges of the plates. Neither does the model account for the stirring process in the copper, which was very complex because it includes phase changes and material flow from the front to the back of the rotating tool. Moreover, the model geometry is symmetric around the weld. It is therefore sufficient to model only one aluminum plate. As a result of fixing the coordinate system in the welding tool, the equation includes a convective term in addition to the conductive term, as follows:

$$\nabla.(-k\nabla T) = \rho c_p u.\nabla T \quad (16)$$

where u is the velocity of the tool.

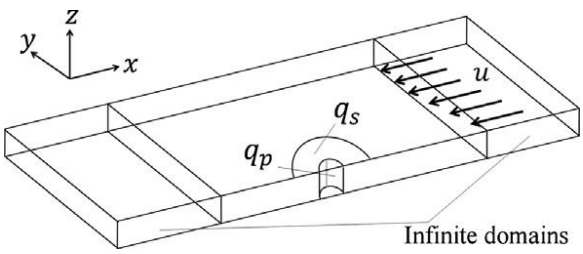

Figure 5. Schematic illustration of the geometry used by Jabbari (2014) in his work

The model simulates the heat generated in the interface between the tool's pin and the workpiece as a surface heat source, which is shown below

$$Q_p(T) = \frac{\mu}{\sqrt{3(1+\mu^2)}} r_p \omega \bar{Y}(T) \qquad (17)$$

where μ is the friction coefficient, r_p is the pin radius, ω denotes the pin's angular velocity, and $\bar{Y}(T)$ refers to the average yield stress of the material.

Additionally, the generated heat at the interface between the tool's shoulder and the workpiece is defined by the local heat flux per unit area (W/m^2) at the distance r from the center axis of the tool:

$$q_s(r,T) = \begin{cases} \left(\frac{\mu F_n}{A_n}\right)\omega r & T < T_{melt} \\ 0 & T \geq T_{melt} \end{cases} \qquad (18)$$

where F_n represents the normal force, As is the shoulder's surface area, and T_{melt} is copper's melting temperature. Above the melting temperature of aluminum, the friction between the tool and the aluminum plate is very low. Therefore, the model sets the heat generation from the shoulder and the pin to zero when the temperature is equal to or higher than the melting temperature.

For initial grain size G_i and final grain size G_f, the energy Q released by grain growth is:

$$Q = 3\gamma\left(\frac{1}{G_i} - \frac{1}{G_f}\right) \qquad (19)$$

where γ is the grain boundary a real energy density and is equal to 0.5 J/m$_3$ for Cu and Q is the released energy. Fig. 6 shows the thermal distribution in the workpiece at various traverse speed during the simulation. The maximum welding temperature stabilized after 28 simulated seconds of FSW. It should be noted that the model does not utilize a dwell time prior to tool advance. As it can be seen, by increasing the traverse velocity the temperature concentration will mostly be located in the center, and close the tool. However, in the low traverse velocities the temperatures are quite distributed evenly in the yz-plane. This can be easily seen from Fig. 7. [9]

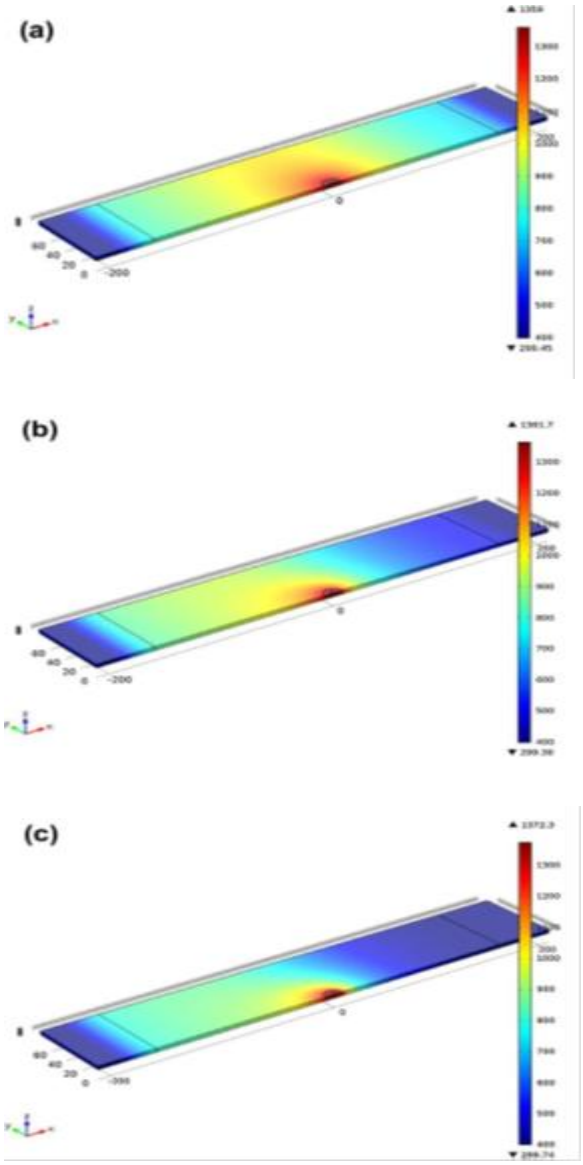

Figure 6. Temperature distribution in the weld with the different traverse velocities of (a) u = 25 mm/min, (b) u = 100 mm/min, and (c) u = 150 mm/min. (Jabbari 2014)

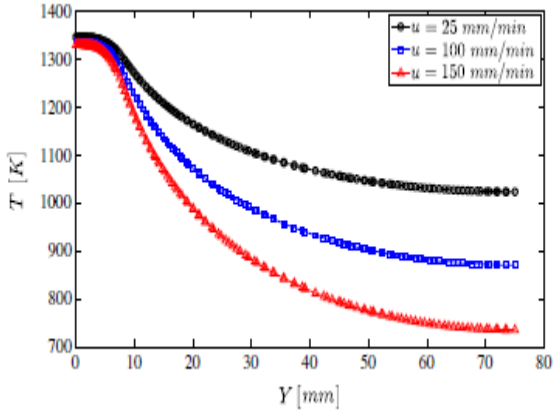

Figure 7. Temperature distribution in the yz-plane and along the y-direction (for reference see Fig. 5). (Jabbari 2014)

S. Mandal et.al. (2006) in their paper provides a theoretical framework for developing a thermomechanical hot channel (THC) approach for augmenting the friction stir welding (FSW) process. The model follows from the Rosenthal solution for moving point sources where heat input from the tool shoulder acts as a warm source while plasmas or laser heat sources provide higher energy input. The THC approach aims at decreasing tool wear by reducing the demand for frictional heat from the tool shoulder and pin. The analytical model presented in their paper was a two dimensional model based on Rosenthal's model of thermal distribution during welding. Three point heat sources were assumed to be moving on a semi-infinite medium. Here, they consider distributed point sources. To simplify the problem, heat transfer by radiation and convection on the surface of the medium is neglected. The Rosenthal model for temperature distribution of a single point moving source was given by,

$$T = T_o + \frac{Q}{2\pi kR} e^{-\nu(\xi+R)/2\alpha} \qquad (20)$$

where Q is the rate of heat supply by the friction stir tool, k the thermal conductivity of the surface, α the thermal diffusivity, ξ = x − vt (moving coordinate system), T_0 the initial temperature of the workpiece, which is considered as 25 ◦C, T the temperature rise due to minor heat source alone, t the time, v the linear speed of the stir tool (welding speed) and $R = \sqrt{(\xi^2 + y^2 + z^2)}$

In this case it is assumed that the heat is generated by a line contact between the rim of the tool shoulder and the workpiece, which is fairly accurate as long the shoulder stays in contact with the workpiece. The heat generated is given by,

$$Q = \int_0^{2\pi} \mu F \omega r d\alpha = 2\pi\mu F\omega r \qquad (21)$$

where F is the downward force applied by the tool on the workpiece, ω the angular velocity of rotation of tool, μ the coefficient of friction between the tool and the workpiece and r is the radius of the tool shoulder. The temperature rise due to stir tool can therefore be calculated from the equation,

$$T = \frac{2\pi\mu F\omega r}{2\pi kR} e^{-\nu(\xi+R)/2\alpha} = \frac{F\omega r}{kR} e^{-\nu(\xi+R)/2\alpha} \qquad (22)$$

Kannatey-Asibu [12] shows that the temperature rise due to dual pre-heating source displaced from the origin is given by

$$\theta_1 = \frac{P_1}{2\pi kR_a} e^{-\nu(\xi' + R_a)/2\alpha} \qquad (23)$$

where θ_1 the temperature rise due to pre-heating source closest to the stir tool, P_1 the heat input from the first pre-heating source, ξ′ = ξ −d_1, d_1 being the separation distance between the stir tool and the first pre-heating source and $R_a = \sqrt{(\xi')^2 + y + z^2}$.

Similarly, the rise in temperature due to the second preheating source is given by,

$$\theta_2 = \frac{P}{2\pi kR_b} e^{-\nu(\xi'' + R_b)/2\alpha} \qquad (24)$$

Where, θ_2 the temperature rise due to second pre-heating source. ξ′′ = ξ − d_2, d_2 being the distance between the stir tool and the second pre-heating source and $R_b = \sqrt{(\xi'')^2 + y^2 + z^2}$.

Eqs. (20) – (22), it can be concluded that the temperature rise due to the heat generated by the stir tool and the two preheating sources can be given by

$$\Theta = \frac{1}{2\pi k}\left[\frac{Q}{R} e^{-\nu(\xi+R)/2\alpha} + \frac{P}{R_a} e^{-\nu(\xi' + R_a)/2\alpha} + \frac{P}{R_b} e^{-\nu(\xi'' + R_b)/2\alpha}\right] \qquad (25)$$

This equation could be generalized to give the temperature rise due to n number of pre-heating sources.

$$\Theta = \frac{1}{2\pi k}\left[\frac{Q}{R} e^{-\nu(\xi+R)/2\alpha} + \sum_{i=1}^{n} \frac{P_i}{\sqrt{(\xi - d_i)^2 + y^2 + z^2}} e^{-(\nu(\xi - d_i) + \sqrt{(\xi - d_i)^2 + y^2 + z^2})/2\alpha}\right] \qquad (26)$$

where n is the number of pre-heating sources, P_i the pre-heating sources for i=1–n and d_i gives the distance of the i_{th} pre-heating source from the stir tool. The concept of a thermomechanical hot channel for preheating during FSW of high hardness materials like steel is analyzed with respect to its effects on tool life improvement. The results indicate that the presence of pre-heating sources ahead of the stir tool, significantly reduce the temperature gradient, as compared to a conventional FSW. This would lead to lesser amount of work done by the tool, which translates to lesser tool wear and longer tool life [10].

X. K. Zhu et.al. (2004) conducted a three-dimensional nonlinear thermal and thermo-mechanical numerical simulations for the friction stir welding (FSW) of 304L stainless steel. The finite element analysis code—WELDSIM, developed by the authors specifically for welding simulation, was used. Two welding cases with tool rotational speeds of 300 and 500 rpm were analysed during this study. The objective was to study the variation of transient temperature and residual stress in a friction stir welded plate of 304L stainless steel. An uncoupled thermal and thermo-mechanical analysis is adapted in their work, which is similar to the numerical simulation of the conventional arc welding. In the thermal analysis, the transient temperature field T is a function of time t and the spatial coordinates (x, y,

z), and is determined by the three-dimensional nonlinear heat transfer equation

$$k\left(\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}+\frac{\partial^2 T}{\partial z^2}\right)+Q_{int}=c\rho\frac{\partial T}{\partial t} \qquad (27)$$

where k is the coefficient of thermal conductivity, Q_{int} is the internal heat source rate, c is the mass-specific heat capacity and ρ is the density of materials.

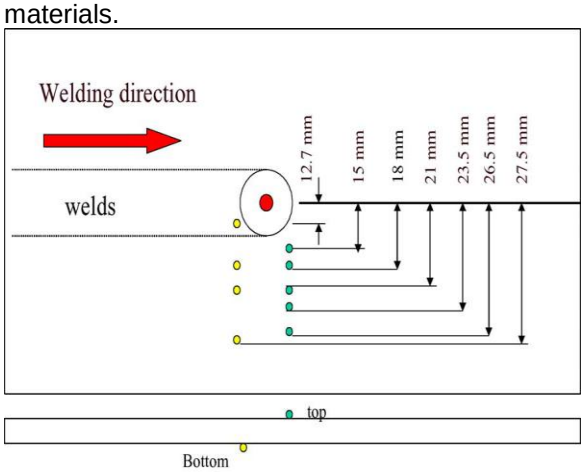

Figure 8. Location of thermocouples in friction stir welding (for the case of 300 rpm tool rotational speed). X.K.Zhu et.al. 2004

It is assumed that the heat flux, q(r), is linearly distributed in the radial direction of the pin tool shoulder, and has the following form

$$q(r)=\frac{12Qr}{\pi(d_o^3-d_i^3)} \text{ for } \frac{d_i}{2}\le r\le\frac{d_o}{2} \qquad (28)$$

where d_o is the outside diameter of the pin tool shoulder, d_i is the pin diameter, and Q is the total heat input energy. In Eq. (28), the heat generated at the pin of tool is neglected because this heat is very small, e.g. in the order 2% of the total heat. As such, in the analysis $d_i = 0$ in (28) was used.

On the boundary or the surfaces of the workpiece, convection and radiation in heat transfer are responsible for heat loss to the ambient. To consider such heat convection and radiation on all plate surfaces except for the bottom surface, the heat flux loss is evaluated by

$$q_s=\beta(T-T_o)+\varepsilon B(T^4-T_o^4) \qquad (29)$$

where T_0 is the room temperature, β is the convection coefficient, ε is the emissivity of the plate surfaces and B = 5.67 × 10−12 W/cm^2 ◦C is the Stefan–Boltzmann constant. In this calculation, β = 10 W/m^2 ◦C and ε = 0.17 are used for the 304L steel. However, the complicated unknown contact resistance between the workpiece and support base presents difficulty in modelling. To circumvent the problem and simplify the analysis, they modelled this heat loss approximately using the heat flux loss by convection as

$$q_b=\beta_b(T-T_o) \qquad (30)$$

where β_b is a fictitious convection coefficient and an undetermined parameter. In addition, a latent heat is taken as 274 J/g to consider the possible phase transformation of the 304L steel during the FSW process. In this current FSW process the values of both Q and β_b are unknowns. Accordingly, an alternative analysis approach has to be investigated for the heat transfer analysis in the FSW. For this purpose, an inverse analysis method is developed in this work to numerically solve the boundary value problem for heat transfer in the workpiece. The analysis strategy is incorporated into the finite element analysis code—WELDSIM.

In the thermo-mechanical analysis, the incremental theory of plasticity is employed. The plastic deformation of the materials is assumed to obey the von Mises yield criterion and the associated flow rule. The relationship of the rate components between thermal stresses, σ_{ij}, and strains, ε_{ij}, is described by

$$\dot{\varepsilon_{ij}}=\frac{1+\nu}{E}\dot{\sigma_{ij}}-\frac{\nu}{E}\dot{\sigma_{kk}}\delta_{ij}+\lambda s_{ij}+\left[\alpha+\frac{\delta\alpha}{\delta T}(T-T_o)\right]\dot{T} \qquad (31)$$

where E is the Young's modulus, ν is the Poisson's ratio, α is the thermal expansion coefficient, $s_{ij} = \sigma_{ij} - 1/3\,\sigma_{kk}\,\delta_{ij}$ are the components of deviatoric stresses and λ is the plastic flow factor. $\lambda = 0$ for elastic deformation or $\sigma_e < \sigma_s$, and $\lambda > 0$ for plastic deformation or $\sigma_e \ge \sigma_s$, here σ_s is the yield stress and $\sigma_e = (3/2 s_{ij}s_{ij})^{1/2}$ is the von Mises effective stress.

Finally the transient temperature field is determined; the residual stresses in the welded plate are then calculated using a three-dimensional elastic–plastic thermo mechanical simulation. The effect of fixture release after the welding on the residual stresses is also studied. Comparison with the residual stress fields measured by the neutron diffraction technique shows that the results from the present numerical simulation have good agreement with the test data. [11]

2. Conclusion

Thermal/thermomechanical modelling of FSW helps to imagine the essential behavior of the welded materials and allows to analyse the effect of different weld parameters (including tool design) and boundary conditions, without performing costly and time consuming experiments. The Thermal/thermomechanical modeling of FSW is a challenging task due to its multiphysics characteristics. The process combines heat flow, plastic deformation at high temperature, and microstructure and property evolution. Thus, nowadays, the numerical simulation of FSW process still cannot be used to optimize the process. The increasing knowledge produced about the computer resources and process can

lead, maybe in a near future, to the use of numerical simulation of FSW to foretell a good combination of the process parameters, replacing the experimental trials actually used. This will help to encourage and develop the FSW process to a wider range of different users and applications.

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DEEP-DRAWABILITY OF TAILOR WELDED BLANKS

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Abstract
One of the aims of the automotive innovations is to reduce car weight, using thinner and higher strength sheet materials. The heavy loaded, and in passenger-safety aspect relevant elements frequently consist of welded sheets. The components could have different strength and sometimes different thickness too. Therefore, certain parts of the welded elements could behave differently during forming and machining. Generally the higher strength coupled with less formability. This paper presents the results of the experimental work, carried out to evaluate the deep-drawability of tailor welded sheets. The welded blanks are prepared from a well drawing component, marked DC04, and from high strength steels: DP 4500, DP600, DP800 and DP1000 type, in each case.

Keywords:
automotive industry, tailor welded sheets, deep-drawability

1. Introduction

Tailor welded blank (TWB) is a blank of two or more sheets, welded into one plane. The components have different thicknesses, or different mechanical properties or different coatings. TWBs are more and more widely used in automotive industry. The aim of the application of TWBs is to reduce the weight of car body, of course while maintaining the high level passenger safety at the same time. Using of high strength steel (HSS) or ultra high strength steel (UHSS) is very expensive. Because of economical reasons, usually only some parts of car body panels (the heavy loaded panels mainly) are made from HSS or UHSS sheets. The forming behaviour of TWBs is influenced by the strength differences between the welded components. The TWBs are made by laser welding technology. [1]
This report deals with the comparison of the HSS and UHSS materials with TWBs, in the field of deep-drawability.

2. Experimental method

The deep-drawability of TWBs was examined by a specially used test to determine the drawability of homogenous sheets, called cup drawing test. The sketch of standard cup drawing test is shown by Fig.1.

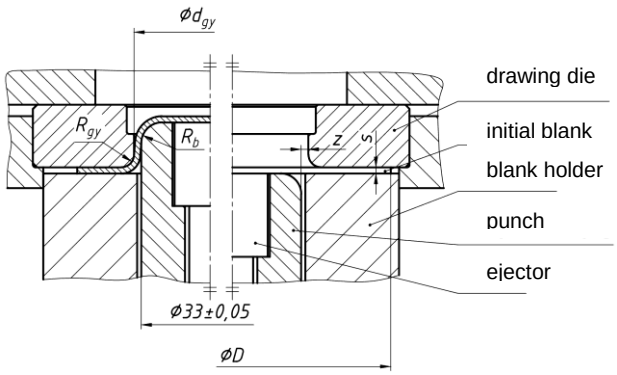

Figure 1. Drawing of the cup drawing test method

The cup drawing tests were realized on the universal sheet tester instrument, type of ERICHSEN 142 (Fig. 2).

Figure 2. Erichsen 142 universal sheet tester instrument

To determine the influence of strength differences for drawability, we applied different sheet materials. The list of the initial blanks is shown in Table 1.

Table 1. Initial blank materials, and its' properties

Material	Th.ness [mm]	Re [MPa]	Rm [MPa]	A80 [%]	z[%]	n	r
DC04	1	179,2	311,7	43,3	55,9	0,221	1,14
DP450	1	345,0	468,0	25,4	60,2	0,166	1,08
DP600	1	450,6	678,7	19,7	70,5	0,144	0,708
DP800	1	603,6	878,2	12,7	57,5	0,102	0,758
DP1000	1	730,7	1050,1	11,3	52,8	0,097	0,733

The mechanical properties of the examined sheets were defined at University of Miskolc (Dep. of Mechanical Technologies) as the leader institute of this research program.
The cup drawing tests were performed at all blanks individually and the welded couples too. Fig 3 shows the initial blank and the drawn cups in case of homogenous DC04 steel sheet.

Figure 3. Initial blank and drawn cups of DC04

All welded pairs consisted of a well drawing steel (marked DC04) and a HSS or UHSS steel sheet (typ. of DP.s). On Fig. 4 DP450 refers to HSS and DP1000 refers to UHSS material.

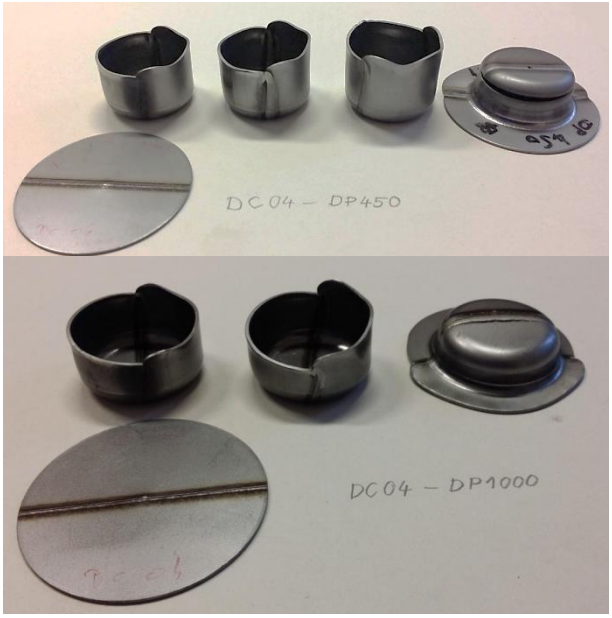

Figure 4. Initial welded blanks and drawn cups of TWBs

The diameters of the initial blanks were varied from 56 mm to 80 mm, by 2mm steps. Cup drawing test reflected the maximum diameter of the blank which is able to be drawn successful, without cranking at the bottom. The ratio of the maximum blank diameter (D_{max}) and the drawing punch diameter (D_{punch}) got the drawing ratio (β) as the drawability parameter of the homogeneous and laser welded sheets (Eq. 1).

$$log\beta = \frac{D_{max}}{D_{punch}}\ [mm] \qquad (1)$$

3. Results

The numerical results of cup drawing tests are summarized, in case of homogeneous blanks in Table 2.

Table 2. Homogenous blanks' cup drawing tests' results

Material	D max	Drawing Ratio
DC04	72	2,18
DP450	64	1,93
DP600	66	2
DP800	66	2
DP1000	62	1,88

During cup drawing tests we measured the drawing forces. Comparison with the drawing ratios, we got the diagrams of drawing forces versus drawing ratios. Diagrams of homogeneous blanks are shown by Fig. 5.

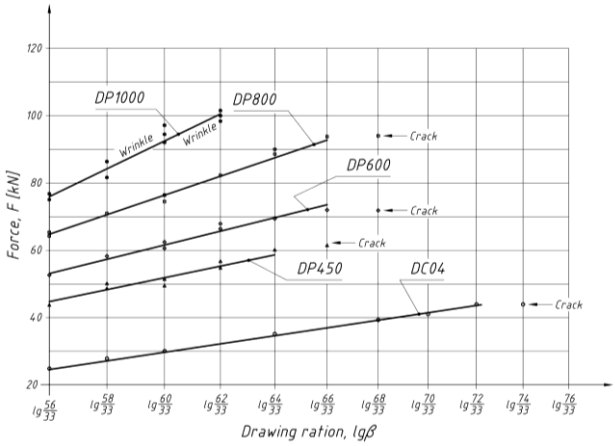

Figure 5. Diagrams of drawing forces versus drawing ratios of homogenous blanks

After the homogenous blanks, the numerical results of TWBs' cup drawing tests' results can be seen in Table 3.

Table 3. TWBs' cup drawing tests' results

Material pairs	D max	Drawing Ratio
DC04 - DP450	66	2
DC04 - DP600	68	2,06
DC04 - DP800	62	1,88
DC04 - DP1000	58	1,76

In Fig. 6 the diagrams of drawing forces versus drawing ratios are visible, refers to TWBs.

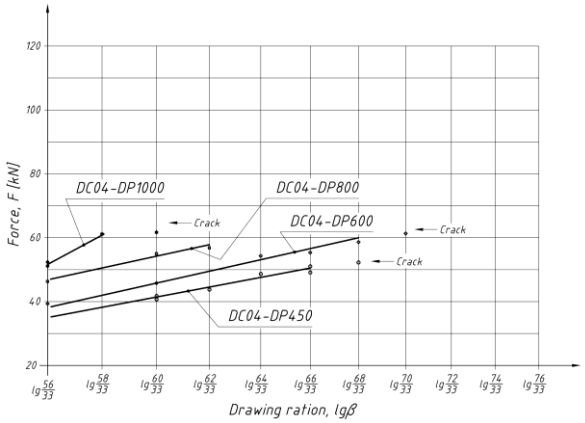

Figure 6. Diagrams of drawing forces versus drawing ratios of TWBs

4. Experiences and problems

Deep drawability of steel sheets is influenced by various technological and tooling parameters. The blank holder pressure seems to be one of the most important parameter with respect to the success of the deep drawing process. In order to forming high strength steel, it is especially important to choose the adequate value as blank holder pressure. In technical literatures, the blank holder pressure only can be found approximately. This can be said for steel and aluminium as well. Before carrying out cup drawing tests, we evaluated a lot of recommendations for choosing blank holder pressure [2, 3, 4, 5]. During our experimental work, we used blank holder pressure values according to literature [3]. Fig.7. shows the diagrams of the applied blank holder pressure for different sheet materials and for different initial blank diameters.

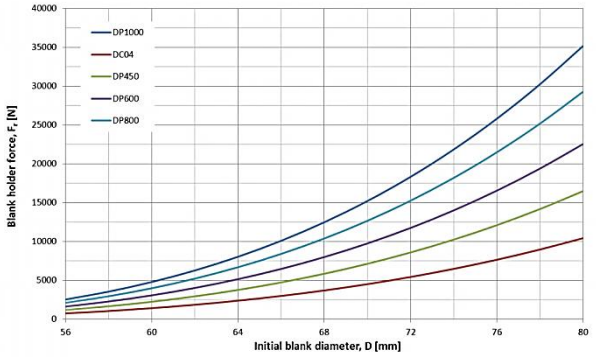

Figure 7. Applied blank holder pressures and the corresponding initial blank diameters

The blank holder pressure values for two different materials are summarized by Table 4.

Table 4. Quantified values for DP1000 and for DC04

DP1000				
R_m	Ød	ØD2	Blank holder pressure [Mpa]	Blank holder forve [N]
1045	33	56	2,91	2539
1045	33	58	3,38	3555
1045	33	60	3,88	4796
1045	33	62	4,40	6285
1045	33	64	4,95	8046
1045	33	66	5,52	10104
1045	33	68	6,12	12486
1045	33	70	6,74	15219
1045	33	72	7,39	18331
1045	33	74	8,06	21852
1045	33	76	8,76	25812
1045	33	78	9,48	30241
1045	33	80	10,23	35172
DC04				
R_m	Ød	ØD2	Blank holder pressure [Mpa]	Blank holder forve [N]
310	33	56	0,86	753
310	33	58	1,00	1055
310	33	60	1,15	1423
310	33	62	1,30	1864
310	33	64	1,47	2387
310	33	66	1,64	2997
310	33	68	1,81	3704
310	33	70	2,00	4515
310	33	72	2,19	5438
310	33	74	2,39	6482
310	33	76	2,60	7657
310	33	78	2,81	8971
310	33	80	3,04	10434

In practice, the choosing of the appropriate blank holder pressure for TWBs' deep drawing was more difficult. If the used blank holder pressure was appropriate for higher strength sheet, the softer sheet cracked. At smaller blank holder force or pressure the wrinkling of the higher strength component caused problem.

5. Conclusion

Homogenous and tailor welded blanks were examined by cup drawing tests. The results pointed that the outcome is significant influenced by the deep-drawability of the lower strength blank. For the shaping of bigger elements, bigger deep drawing force necessary, which cannot be tolerated by the lower strength component. So the deep-drawability of TWBs is limited by the cracking of the softer component, next to the welded line.
In addition, welded components with different strength need different blank holder force, but providing discrepant pressures at the same is not possible. That is why further investigations are needed.

Acknowledgement

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INTEGRITY ASSESSMENT OF A STRUCTURE MADE OF TWO FSW T-WELDS

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Abstract
Topic of this paper is fatigue crack growth analysis and structural integrity assessment of Al 2024-T351 thin plate with double „T“ joint made by friction stir welding (FSW). This structure has been modeled in Abaqus, as a plate under fatigue tensile load with R=0. The eXtended Finite Element Method (XFEM) has been used. Through-thickness crack has been introduced in the center of the plate, symmetrically positioned between two FSW „T“ joints. The stress intensity factors have been calculated for each step of crack growth, in every point on the crack front. As the final result, an estimation of fatigue life of the thin plate welded Al 2024-T351 cracked structure has been obtained.

Keywords:
Fatigue crack growth, Friction Stir Welding, eXtended Finite Element Method

1. Introduction

It is now more then two decades that the *Friction Stir Welding - FSW*, has found its wide application in many industries, including aeronautical (e.g. A380), because of many advantages of the integral welded structure over the other joining methods (bolts, screws), [1,2]. Although there is no melting when FSW is used, and common cracking problems are thus avoided, it is still of great interest to assess structural integrity of Al 2024 alloy welded joints, i.e. to estimate fatigue crack growth resistance. There have been numerous experimental investigaiton of this phenomenon, followed by its numerical simulation. In this paper, main focus is on the application of eXtended Finite Element Method (XFEM) in combination with ABAQUS /MORFEO to simulate fatigue crack growth of Al 2024 alloy friction stir welded joint. Typical structural element has been chosen for this simulation – thin-walled plate with symmetric stiffeners, in the shape of T joints.

2. Crack initiation and growth in thin-walled structures

Aircraft structure is typically prone to cracking because of high fatigue loading, often in combination with overloading. Some of typical cracking problmes are classified as follows, and shown in Fig. 1 and 2:

- Crack in one segment (Fig. 1);
- Crack in two segments (Fig. 2).

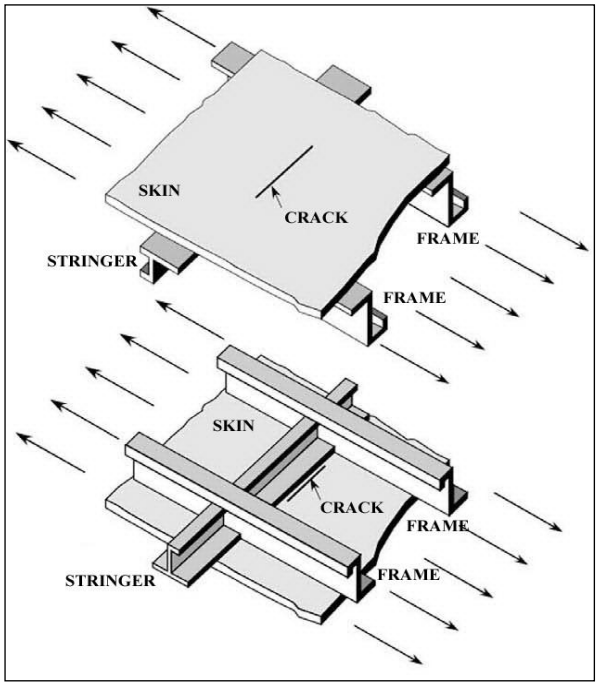

Figure 1. Typical part of an airplane hull construction, with a crack next to the stringer

Fatigue can cause longitudinal cracking in one segment, typically at a skin and stringer joint, Fig. 1. Longitudinal crack can be initiated at a skin itself, growing into both surrounding segments, Fig. 2.

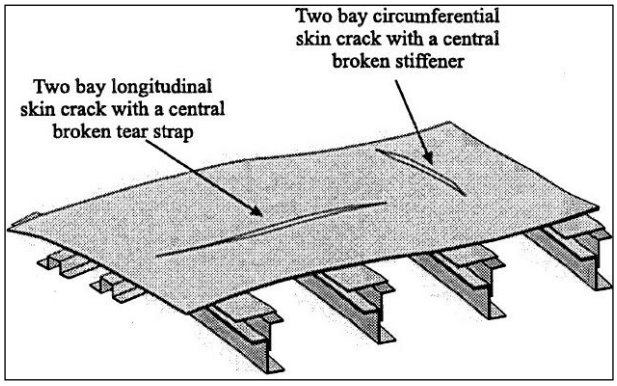

Figure 2. Crack in two segments, [4]

Figure 3 shows crack growth close to stringer, for both differential and integral type of structure. The later one indicates crack branching toward the stringer.

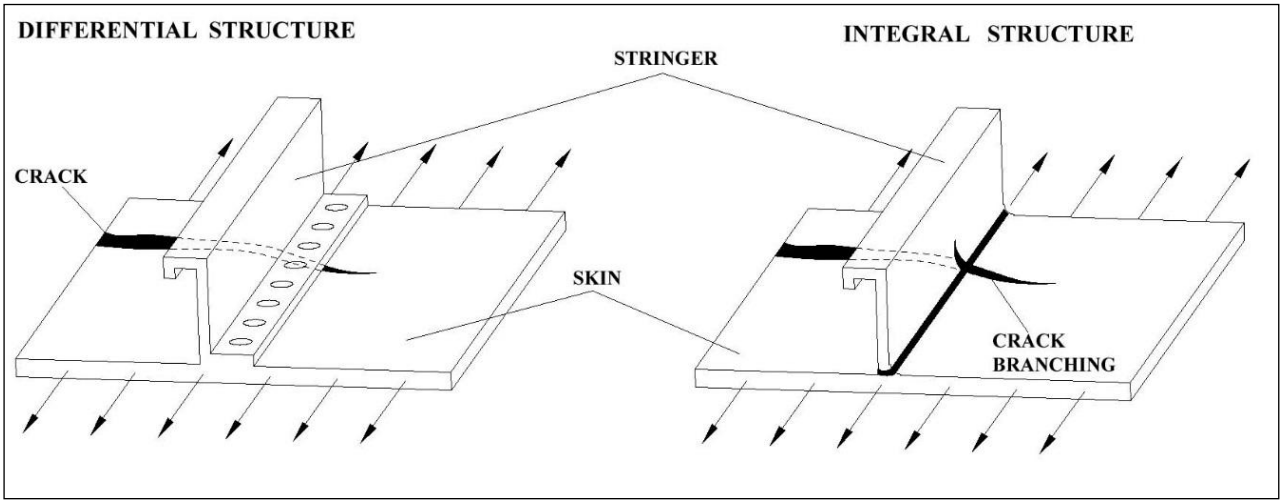

Figure 3. Crack propagation in a differential, i.e. integral structure, [5]

3. Plate with two FSW T-joints [6]

Plate with two FSW T joints, has been analysed as a typical strenghten thin-walled structure. Geometry has been given in Fig. 4. For numerical simulation a model has been created with the following dimensions: 1 x 20 x 144 mm, Fig. 5. Plate was made of Al 2024-T351 alloy, containing an initial crack with length $2a_0$=3 mm, between two T joints, positioned symmetrically, Fig. 4 and 5.

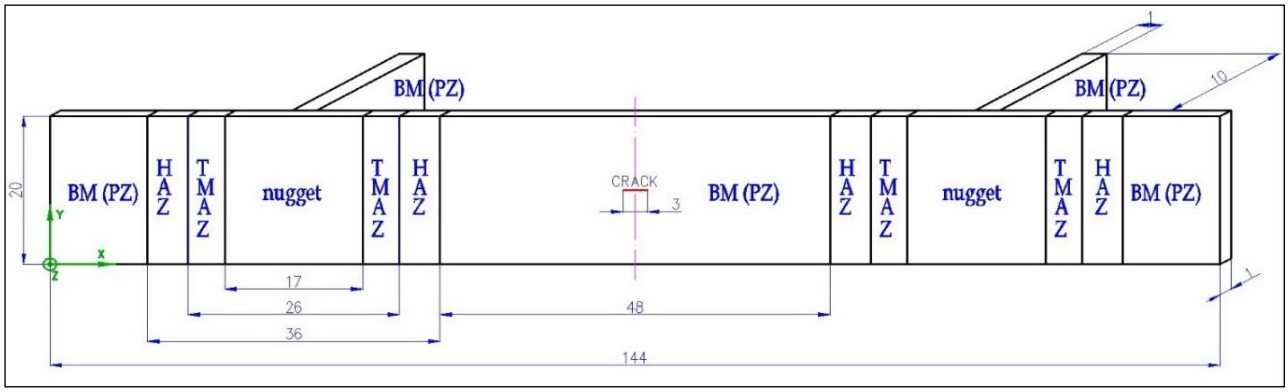

Figure 4. Plate reinforced with two FSW T-joints, [6]

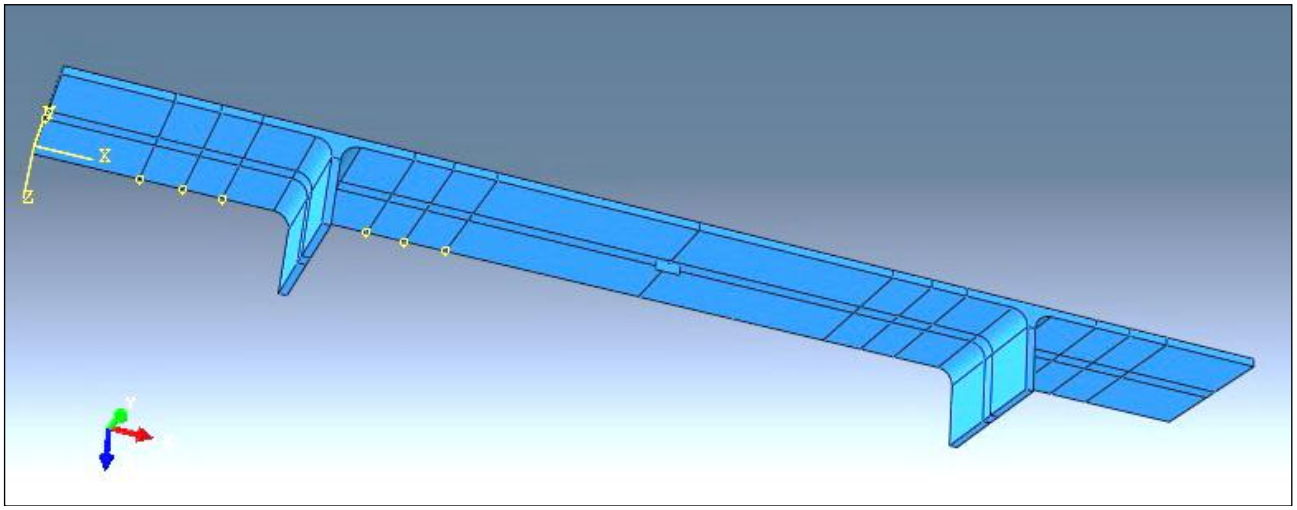

Figure 5.The 3D model of a plate reinforced with two FSW T-joints

Abaqus was used for 3D modeling of plate, including boundary conditions and loading, reinforced with two FSW T joints, Fig. 5. Different zones in FSW joint (nugget, ThermoMeachnically Affected Zone – TMAZ, and Heat-Affected-Zone – HAZ) have been treated as materials with different properties, as taken from [7] and given in Tab. 1 for *Young's* elasticity modulus (E) and *Poisson's* ratio (ν), in Tab. 2 for stress-strain relation in plasticity, $\sigma = \sigma(\varepsilon)$, and in Tab. 3 for constants in *Paris* equation (C and n).

Table 1. Young's elasticity modulus (E) and Poisson's ratio (v)

FSW zones	nugget	TMAZ	HAZ	BM (PZ)
Young's modulus of elasticity - E [MPa]	68 000	68 000	68 000	68 000
Poisson's coeficient- ν	0.33	0.33	0.33	0.33
yield strength- σ_t [MPa]	350	272	448	370
strain hardening coeficient- α	-	800	719	770
strain hardening exponent- n	-	0.1266	0.05546	0.086
hardness-HV	142	118	167	132
residual stress - [MPa]	-41	95	-20	0

Table 2. Stress-strain relation in plasticity

nugget		TMAZ		HAZ		BM (PZ)	
σ [MPa]	ε [–]	σ [MPa]	ε [–]	σ [MPa]	ε [–]	σ [MPa]	ε [–]
30.43	0.00044	50.34	0.00070	25	0.00040	20	0.0003
51.30	0.00080	75.86	0.00123	35	0.00060	40	0.0006
69.56	0.00120	106.90	0.00160	58	0.00100	45	0.0009
91.30	0.00150	131.03	0.00200	83	0.00126	90	0.0014
130.43	0.00210	186.21	0.00310	95	0.00150	125	0.0021
186.95	0.00320	268.96	0.00450	130	0.00200	220	0.0034
286.96	0.00430	331.03	0.00570	175	0.00280	300	0.0050
331.91	0.00550			280	0.00438	320	0.0058
				330	0.00558	440	0.0084
				480	0.00898	487	0.0120
				540	0.01166		

Table 3. The constants in Paris equation (C and n)

FSW zones	Paris's model	Bussu-Irvin's experiments	Ali's experiments	regression calculations
nugget	C [$number\ of\ cycles$]$^{-1}$	$2.02345 \cdot 10^{-10}$	$2.02345 \cdot 10^{-10}$	$2.8338 \cdot 10^{-12}$
	n	3.106	2.94	3.80
TMAZ	C [$number\ of\ cycles$]$^{-1}$	$3.987 \cdot 10^{-10}$	$2.02345 \cdot 10^{-10}$	$5.5837 \cdot 10^{-12}$
	n	2.254	2.94	2.76
HAZ	C [$number\ of\ cycles$]$^{-1}$	$8.41 \cdot 10^{-11}$	$2.02345 \cdot 10^{-10}$	$1.1778 \cdot 10^{-12}$
	n	2.28	2.94	2.79
BM (PZ)	C [$number\ of\ cycles$]$^{-1}$	$2.035 \cdot 10^{-10}$	$2.02345 \cdot 10^{-10}$	$1.1778 \cdot 10^{-12}$
	n	2.4	2.94	2.94

Fatigue crack growth has been analysed by using *ABAQUS/Morfeo sofware*, with loading coefficient $R = 0$ and maximum tensile stress $\sigma = 270\,MPa$.

4. Results and discussion

Results for the stress intensity factors at the left and rigth crack tip are given in Tables 4 and 5, for 15 crack growth steps (each 1 mm), as well as in Fig. 6.

Table 4. Numerical data: change of stress intensity factor with crack growth (left crack end) [6]

left side	x [mm]	y [mm]	K_I [MPa mm$^{0.5}$]	K_{II} [MPa mm$^{0.5}$]	K_{III} [MPa mm$^{0.5}$]	K_{eq} [MPa mm$^{0.5}$]
step 1	70.5	10	1379.519	11.96667	2.769037	1380.987
step 2	70.00665	10.00857	1707.997	-5.75218	-0.02053	1712.546
step 3	69.50936	10.01383	2008.302	20.52614	4.892032	2009.413
step 4	69.01922	10.0291	2350.873	1.454398	-0.62923	2357.784
step 5	68.53378	10.0447	2773.498	9.229958	-3.01633	2779.507
step 6	68.04161	10.06412	3192.059	23.30958	-3.91823	3195.562
step 7	67.55057	10.09013	3760.385	5.140441	-32.6163	3774.678
step 8	67.05951	10.11873	4291.625	39.0058	-47.4168	4301.316
step 9	66.56807	10.15436	4994.479	-3.81559	-136.885	5036.77
step 10	66.08071	10.19295	5408.598	263.7405	-3.17539	5424.058
step 11	65.59246	10.26405	6181.849	102.7304	-82.6665	6297.388
step 12	65.09811	10.34578	7338.482	-9.40266	-48.2834	7457.198
step 13	64.62029	10.43622	8173.664	453.1047	49.33813	8366.499
step 14	64.17953	10.5561	11118.07	-137.099	-35.0431	11188.15
step 15	63.69962	10.67492	19917.9	1333.884	-298.615	20212.82

Table 5. Numerical data: change of stress intensity factor with crack growth (right crack end) [6]

right side	x [mm]	y [mm]	K_I [MPa mm$^{0.5}$]	K_{II} [MPa mm$^{0.5}$]	K_{III} [MPa mm$^{0.5}$]	K_{eq} [MPa mm$^{0.5}$]
step 1	73.5	10	1380.412	10.73161	-1.08353	1381.583
step 2	73.99538	10.00774	1708.006	-3.53592	-0.05448	1710.904
step 3	74.49156	10.01335	2014.15	19.47255	-8.20621	2013.548
step 4	74.98744	10.02861	2344.686	4.863504	-0.25838	2352.477
step 5	75.46848	10.04538	2774.63	2.617907	-1.06733	2777.676
step 6	75.96273	10.06357	3180.131	31.01856	-0.42327	3184.955
step 7	76.4476	10.09083	3767.996	1.677378	-5.83616	3776.995
step 8	76.94208	10.11935	4295.342	47.08182	-23.9263	4300.758
step 9	77.43422	10.15796	5035.297	13.73122	-30.216	5038.853
step 10	77.9328	10.20004	5233.373	368.8229	-70.3152	5285.261
step 11	78.37985	10.2814	6091.376	-101.545	-71.8804	6243.163
step 12	78.84959	10.35801	7274.243	181.4375	-159.705	7493.538
step 13	79.34355	10.44643	8353.037	648.4696	-158.658	8534.046
step 14	79.82812	10.56399	10913.88	245.1018	-322.748	11371.55
step 15	80.27252	10.68868	20186.45	557.9952	-340.774	20398.21

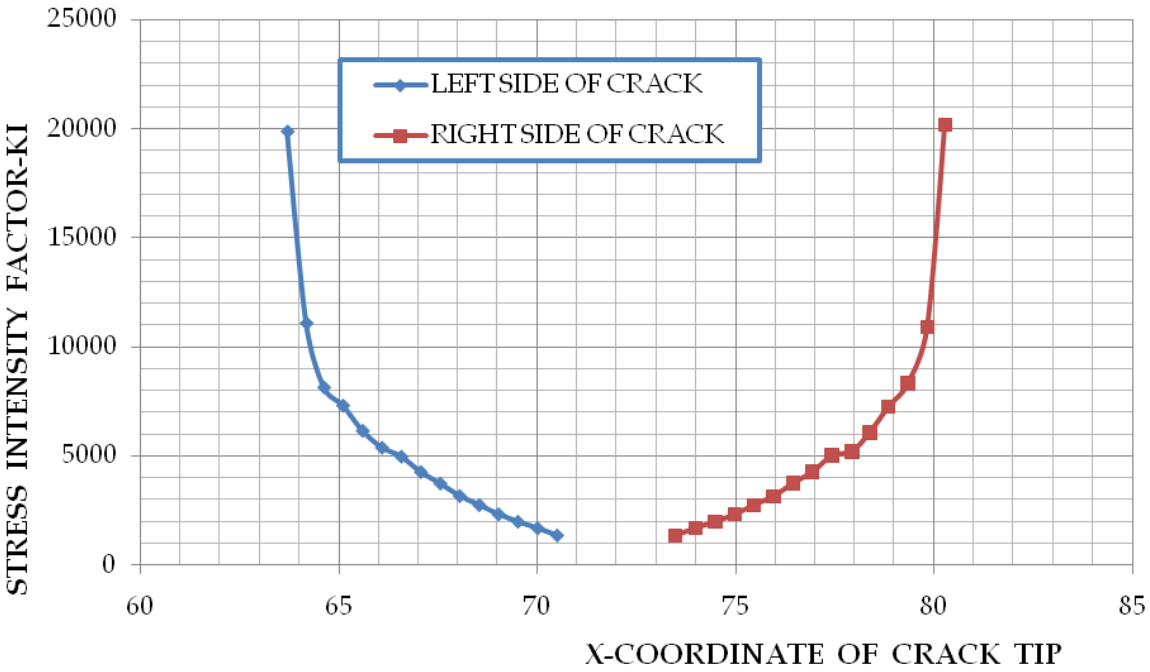

Figure 6. Change of stress intensity factor with crack growth [6]

As in the case of simple plate, shown in [6], there is a sudden increase of crack groth rate. Anyhow, higher stress intensity factors are needed in the case of strenghten plate, indicating that stiffeners (stringers) redistribute load, relaxing the plate, and increasing its fatigue life, at the same time. Data for crack growth (15 steps - 15 mm) is given in Figure 7 and Table 6.

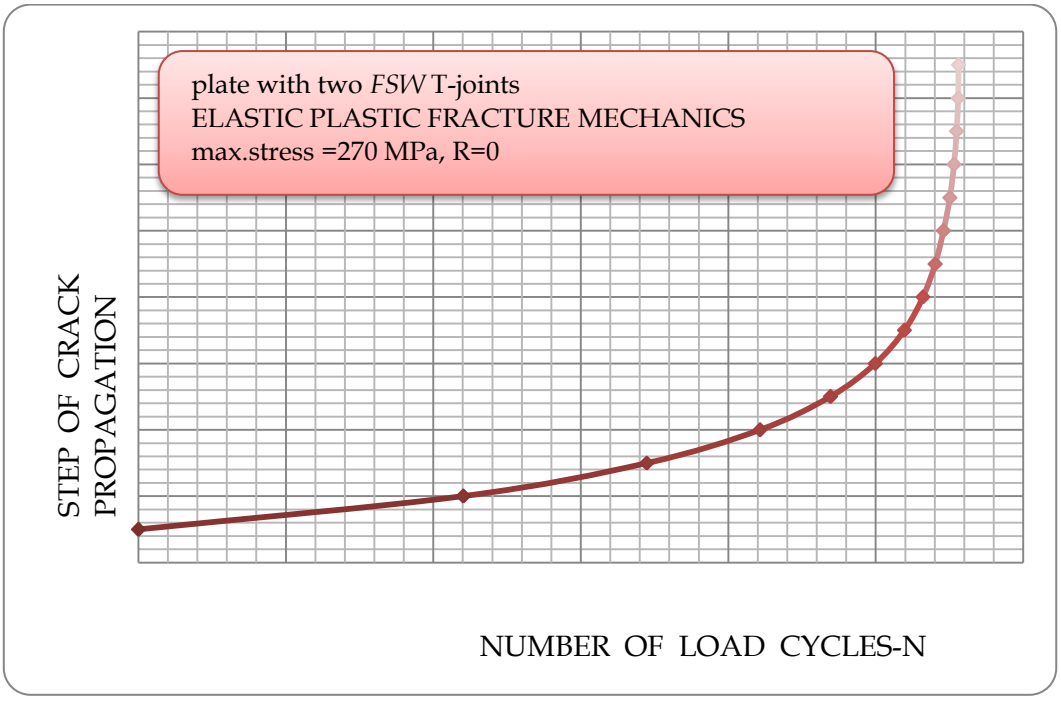

Figure 7. Crack propagation as a function of load cycle number – N, [6]

Table 6. Numerical date: crack growth vs number of cycles - N , [6]

step	ΔN	N
1	0	0
2	1.10223	1.10223
3	0.621435	1.723665
4	0.3836	2.107265
5	0.239019	2.346284
6	0.152462	2.498746
7	0.0980426	2.5967886
8	0.0628516	2.6596402
9	0.0415641	2.7012043
10	0.0288137	2.730018
11	0.0214726	2.7514906
12	0.0139602	2.7654508
13	0.0087029	2.7741537
14	0.0050573	2.779211
15	0.0018127	2.7810237

5. Conclusion

In this paper, crack growth in reinforced thin-walled structures was analyzed For reinforced plate model, i.e. a plate that contains two FWS T-joints, crack growth in the domain of base material was taken into consideration, between two FSW T-joins. During its stable phase (stable crack growth), the crack does not cross into the remaining zones of the FSW joint, but instead propagates within the base material.

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DETERMINATION OF RECRYSTALLIZATION TEMPERATURE OF VARYING DEGREES FORMED ALUMINIUM, BY DMTA TECHNIQUE

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Abstract
Manufacturing of aluminium strips are usually done by cold rolling. Due to the rolling, the material run out of formability and the aluminium hardens. For subsequent shaping annealing and recrystallization is necessary.
The temperature of the recrystallization highly depends on the grade of the subsequent shaping. If the recrystallization temperature is too high, or coupled with too long time, the particles might get rough. While at lower temperatures than required, the mechanical properties cannot become favourable, the hardness remains. Small specimen test is a current process to determine the appropriate temperature of recrystallization. The test requires many specimens, and lots of time. In this paper we present a simpler and faster method to determine temperature of recrystallization.
For the accurate definition of the recrystallization temperature, the Dynamic Mechanical Thermal Analyser (DMTA) method - received from polymer science - gathers ground. The equipment measures the change of the mechanical characteristics, during given heating rate, and concludes certain transformations, based on the changes.
The article compares the results of the small specimen test and the DMTA method, considering the temperature and the forming dependence of recrystallization temperature.

Keywords:
DMTA, recrystallization, cold forming, Al alloy

1. Introduction

In order to see how the measurement method is applicable, we prepared AlMg3 specimens with different shaping grade. The rolling was done by duo roll stand, the shaping grade ranged from 30 to 90 %. More differently shaped specimens were processed than the commercially available rolling states, to get more accurate measurements' results.
The initial thickness was 1mm in all cases. Before the last rolling, the specimens were annealed due to the homogeny structure, as suggested by the literature. [1]

During cold rolling, the mechanical and physical properties of the metals change. The strength greatly increase, while ductility, and deformation capacity decreases. Of course, the properties depend on the shaping grade. This is because the crystal lattice distorted in the deformed particles and the dislocation density increases. [2]
In the deformed crystal lattice, the atomic distance is changed from the original minimum energy state. Depending on the degree of displacement, the atoms get extra energy. Whereas, the distance among the atoms mostly determined by the shaping grade, it might say, that higher forming gets higher extra stored energy. [3]
During the rolling, the grain boundaries, and the dislocations moves on, while new dislocations generated. The amount of dislocations is varied by the penetration, or the tearing out of atomic-lines. This symptom also involves the movement of the atoms, so the creation of the dislocations also causes an increase in energy. Furthermore, the increased number of the dislocations prevents each other in the movement, following forming needs higher stress. This hardening is able to present by hardness testing [Fig. 1].

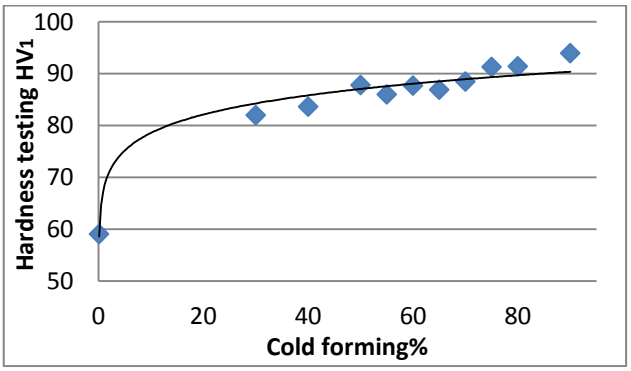

Figure 1. Hardening of AlMg3

The materials aim to reach the lowest-energy state. The raising of the temperature provides the opportunity to start the necessary diffusion process. The diffusion (thermally activated process) is stimulated by the energy state difference between the initial and the final conditions. Result of the annealing, the internal stress, the hardness, and the strength values

return to the state before forming. The amount of dislocations also returns to its equilibrium value. In the structure of the material new seeds appear, and solid-state crystallization occurs. This process is called recrystallization, shown by Figure 2. Higher forming grade causes higher stored energy, which results the decrease of the transition temperature. [4] In this paper, this temperature changing is examined.

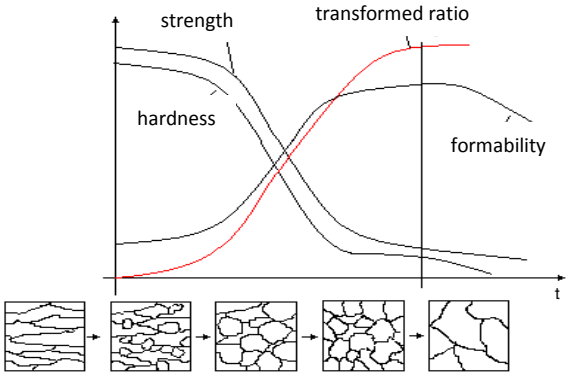

Figure 2. Changing of the granular structure and the mechanical properties due to the recrystallization. The transformation ratio indicates the amount of recrystallized grains.

2. Small specimen test

To determine the parameters of the recrystallization, experimental series were performed by hardness testing. The sampling temperature was grown by 50°C from 200 °C to 300 °C. Over 300 °C, samples were taken in every 25°C [Table 1]. Initially, the heating lasted for half an hour in every case, then the time was raised to one and half, and three hours, at the favourable temperature ranges.

The sample geometry was 50 x 50mm, the forming grade was 80 %. At other forming grades the results shown similar values, cause the inaccurate furnace temperature control.

The heat treatment was done by OH 63 chamber furnace, without protective atmosphere.

The small specimen tests revealed that annealing up to 250 °C for 90 minutes did not cause relevant changes in hardness. However, stress relaxation might cause slight reduction of hardness values. Annealing on 300 °C for 30 minutes reduces hardness significantly. Beyond this range the changes of annealing time and temperature do not affect to the specimen's hardness greatly.

Table 1. hardness values of AlMg3 after heat treatment, at 80% forming grade

Annealing temperature [°C]	Annealing time [min]	Measurement number HV_1				Mean HV_1
		1	2	3	4	
20	0	88,6	91,8	90,2	91,1	90
200	30	87,7	88,8	88,5	88,9	88,5
	60	85,1	85,3	84,1	86,7	85,3
	90	84,2	84	85,1	83,4	84,2
250	30	80,7	80,5	81	79,7	80,5
	60	81,4	79,4	78,5	79,8	79,8
	90	79,2	79	78,9	79	79,0
300	**30**	**55,1**	**55,7**	**55,1**	**55,3**	**55,3**
	60	57,2	57,1	56,5	56,9	56,9
	90	57,5	55,5	56,3	56,4	56,4
325	30	54,9	55,7	56,4	55,8	55,7
	60	54,8	55,9	57,1	55,9	55,9
	90	56,8	56,1	56,6	56,5	56,5
350	30	54,5	54,7	55	54,7	54,7
	60	57,3	57,3	57,2	57,4	57,3
	90	57,3	57,8	57	57,4	57,4

Figure 3 shows the Vickers hardness test's results in function of isothermal temperatures, in case of 30 minutes annealing.

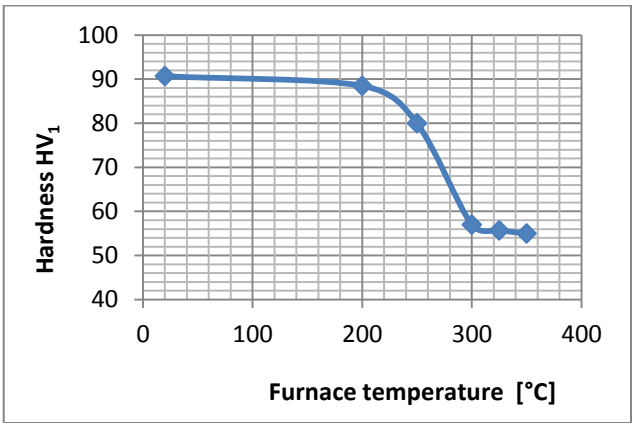

Figure 3. Hardness test results in function of furnace temperature in case of AlMg3 sample, 30 minutes annealed

3. DMTA results

The dynamic mechanical thermal analyzer (commonly known as DMTA) creates a direct link between the materials' chemical structure and mechanical properties. The transitions are generated by heating or cooling, among dynamic conditions. The samples can be fixed in various clamps which can vibrate the specimen with a specified sinusoidal load and amplitude. Our measurements were made in tensile and bending clamps. The clamps are placed in a furnace filled

with neutral gas (nitrogen), which heats or cools, with a guided rate. Figure 4 shows the DMTA results of a 90% formed sample.

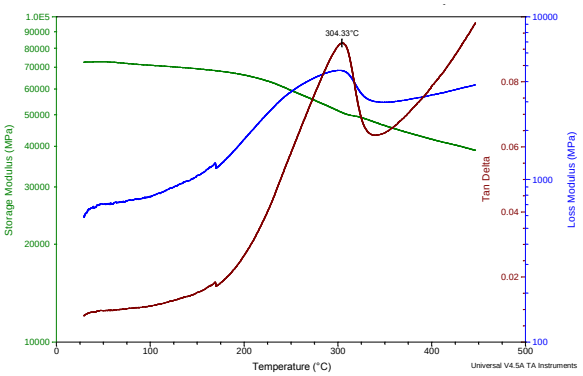

Figure 4. DMTA curves of a 90% formed AlMg3 sample

The dimensions of the sample are 18 x 5mm. The specimen was heated up to 450 °C with 3 °C/minute heating rate in a two point bending clamp. The frequency was set to 5 Hz, the deformation amplitude was 5 µm. The green curve shows the storage modulus of the material which is proportional to the Young modulus. The blue curve shows the loss modulus which originates from the internal friction during the transformation of the atomic structure. The quotient of these two values is the tanδ. The tanδ peak shows where the transformation occurs. In case of Figure 4, the tanδ peak locates the recrystallization at 304,3 °C.
Figure 5 shows the discrepancythe tanδ curves of the 30% formed and 90% formed samples. The results show that the transformation temperature depends on the shaping grade.

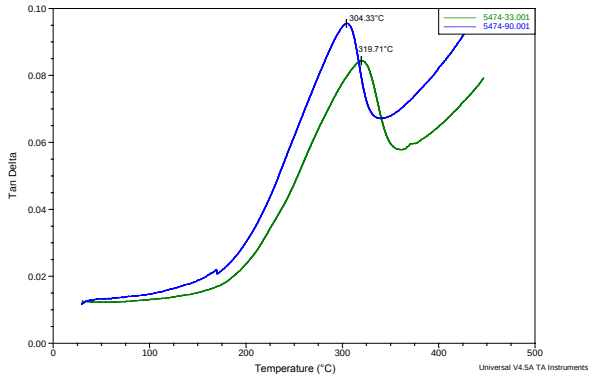

Figure 5. Tan delta curves of the 30% and 90% formed samples

Figure 6 summarizes our results by showing the recrystallization temperatures in function of shaping grade.

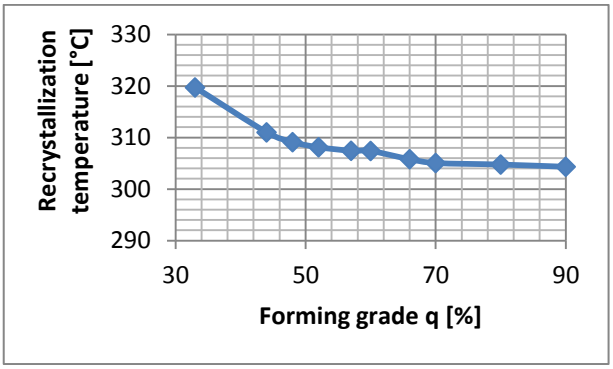

Figure 6. Recrystallization temperatures in function of shaping

4. Conclusion

We managed to measure the effect of cold forming on the recrystallization temperatures using DMTA equipment. The small specimen tests and the hardness tests verify the DMTA results. We are able to measure the recrystallization temperature of specimen with an unknown shaping grade quickly and precisely, thereby we can avoid the wrong setup of parameters.

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UTILISATION OF OPTICAL 3D SCANNING METHODS IN MEASUREMENT OF WELD JOINT DEFORMATIONS

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Abstract
The paper evaluates the applicability of optical 3D scanning on measurement of butt joints deformations originated from welding. There were compared three welding methods (GMAW, GTAW and LBW) characteristic by different specific heat input. The final weld joints deformation measurements were carried out by GOM ATOS II Triple Scan scanner. The paper discusses possible difficulties of weld joints scanning, obtained data interpretation and scanning method resolution as well.

Keywords:
ATOS, 3D scanning, welding, deformations

1. Introduction

During the welding thermal cycle, complex transient thermal stresses are produced in the weldment and the surrounding joint. The weldment also undergoes shrinkage and deformation during solidification and cooling [1]. The deformation removal costs or expenses relatedto their prevention are estimated up to 20 % of total costs spent for welding.

At a moment, the contact measurement methods are frequently used for measuring the weldment deformations [2]. However, the application of contact methods for complex description of whole weldment deformation is enormously time consuming [3].

The possible alternatives of obtaining 3D model of deformed weldment are non-contact optical scanning methods being widely used at a moment in the others industrial fields, e. g. architecture, civil and reverse engineering, automotive industry, inspection, etc. [4], [5]. Some of these methods are capable to provide dense sampling which can be used for detailed description of deformed weldment or bead geometry [6]. Today's advances in the field of computer simulation of welding processes make possible to predict final weldment deformation and residual strain, as well as geometric parameters of weld bead, e. g. bead width, height, reinforcement, or even surface weld defects [7], [8], [9]. Digital 3D model of weldment acquired by optical 3D scanning can be therefore used also in verification of welding process computer simulation.

2. Method

Low carbon steel plates with dimensions of 75x200x1.5 mm were used in experiment. The butt weld joints were prepared by welding two pieces of steel plates using different welding methods characteristic by a different heat thermal input: Gas Metal Arc Welding (manual and automated), Gas Tungsten Arc Welding and Laser Beam Welding.
The welding parameters of particular welding method are introduced in Table 1. and Table 2. Pure argon as a protective gas was used.

Table 1. Arc welding parameters

Parameter/ welding method	GMAW manual	GMAW automated	GTAW manual
Welding Current [A]	110	104	51
Welding voltage [V]	19	19.5	13.7
Filler metal diameter [mm]	1.0	1.0	1.6
Gas flow rate [l.min^{-1}]	10	10	8
Welding speed [mm.s^{-1}]	11.8	10	1.05

Table 2. Laser beam welding parameters

Beam power [kW]	0.850
Focus [mm]	1 mm above material surface
Gas flow rate [l.min^{-1}]	7
Welding speed [mm.s^{-1}]	20
Nominal heat input [kJ.mm^{-1}]	0.0425

Thermal heat input Q for arc welding was calculated according equation (1), where *U* is welding voltage in V, *I* is welding current in A, *v* is

welding speed in mm.s^{-1} and η is process efficiency (GMAW = 0.8; GTAW =0.6).

$$Q = \frac{\eta . U . I}{v} \quad [kJ.mm^{-1}] \qquad (1)$$

Thermal input Q for laser beam welding was calculated according equation (2), where η is process efficiency (laser beam welding of low carbon steel = 0.6), *BP* is used beam power in kW and *v* is welding speed in mm.s^{-1}.

$$Q = \eta \cdot BP/v \quad [kJ.mm^{-1}] \qquad (2)$$

The different thermal heat input (Table 3.) led to different amount of weldment deformation.

Table 3. Calculated Heat Input of Different Welding Methods

	GMAW manual	GMAW automated	GTAW	LBW
Q [kJ.mm^{-1}]	0.142	0.162	0.399	0.026

Prior to welding, 5 mm long tack welds were carried out at the both ends of the materials to be welded. The reference points were then stuck to the materials and their surface was covered by antireflection coating. The reference points were then cleaned out of antireflection coating.
Taking into account the whole volume of material is deformed during welding, there is not possible to define any absolute point to which the deformation could be related. In order to define a co-ordinate system with its origin out of the weldment, the fixture situated on rotating table and based on precise machined cube was used (Figure 1.). The deformation of weldment with relation to created co-ordinate system was therefore possible to evaluate before and after welding.

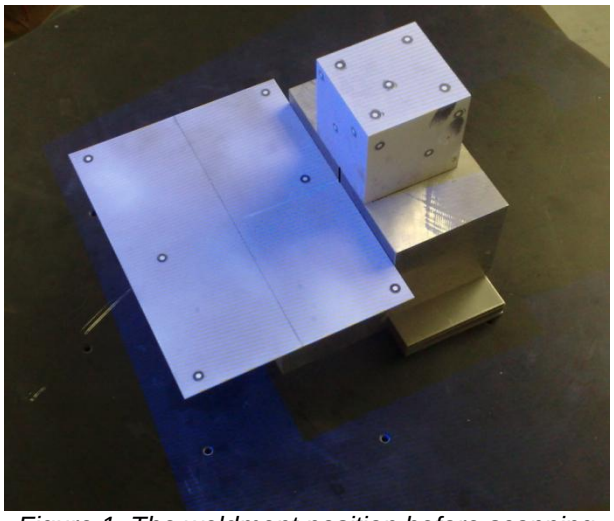

Figure 1. The weldment position before scanning

The digitizing operation was provided by optical 3D scanner GOM ATOS II Triple Scan SO using measuring volume MV 320 (320x240x240 mm). The materials prepared by procedure described above were scanned. Antireflection coating was consequently removed in order to avoid any arc instabilities during welding. After welding, the coating was recreated and weldment was scanned again. Every specimen was scanned at 12 positions, rotating the table by 30 degrees. The GOM ATOS software package was used for evaluation of weldment deformation represented by colour deviation map. The example of final weldment scan together with fixture defining the co-ordinate system is shown in Figure 2. The fixture was afterwards removed from the final weldment final weldment digitized 3D model.

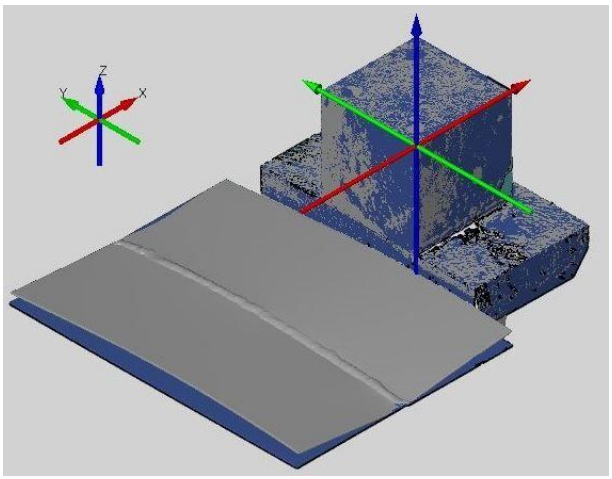

Figure 2. A scan of weldment and fixture with marked origin of co-ordinate system

3. Results

Graphical visualisation of deformations after welding by particular welding method is presented in Figures 3., 4., 6. and 7.

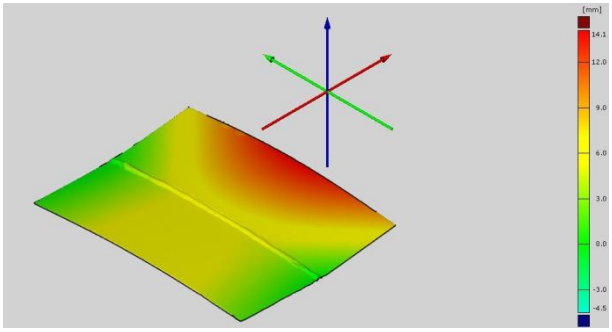

Figure 3. Deformation of weldment after manual GMAW

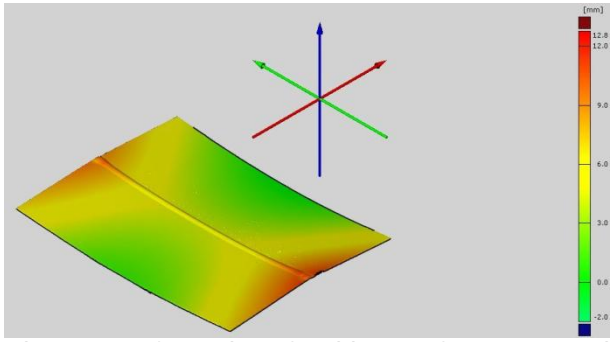

Figure 4. Deformation of weldment after automated GMAW

The maximal deformation after manual GMAW was 14.1 mm (Figure 3.). The maximal deformation of weldment prepared by automated GMAW was 12.8 mm (Figure 4.). This could be explained by weldment fixation during automated welding (Figure 5.), despite the higher heat input (Table 3.).

Figure 5. Fixation of materials prior to automated GMAW

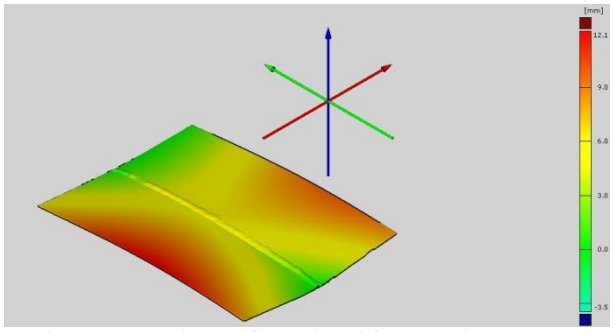

Figure 6. Deformation of weldment after GTAW

The maximal deformation of weldment fabricated by GTAW method (Figure 6.) was 12.1 mm, i. e. less than automated GMAW (Figure 4.). On the other hand, the area of deformation exceeding 5 mm is larger (Figure 6. vs. Figure 4.), which corresponds to the highest heat input among used welding methods (Table 3.).

As expected, the maximal deformation of weldment after laser beam welding was the lowest (1.25 mm) from the all tested welding methods (Figure 7.). This can be also explained by the lowest heat input, which was approximately 15 times lower in comparison to GTAW method.

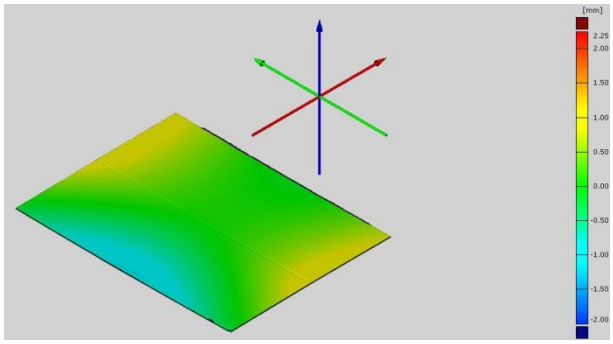

Figure 7. Deformation of weldment after laser beam welding

4. Discussion

The prior goal of the research was to verify, whether optical 3D scanning can be acceptable for evaluation of weldment deformation. The results revealed, that the resolution of GOM ATOS II Triple Scan equipment could even depict the surface structure of the weld bead, as well as weld metal spatter, remaining tack weld (Figure 8.) and mutual connection of two weld beads (Figure 9.). Scanner resolution was sufficient for detection of different surface weld joint defects, e. g. bead reinforcement, weld undercuts, surface pores, residual surface slag, etc.

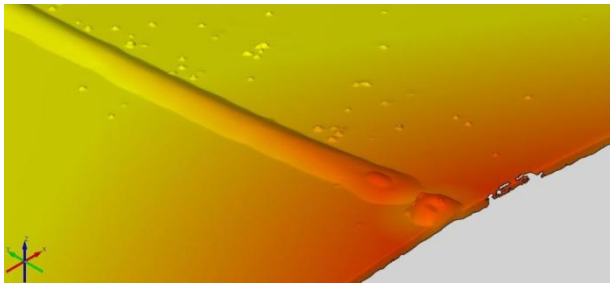

Figure 8. The weld metal spatter close-up after automated GMAW

It is worth mentioning that measuring system had certain problem with scanning the plate thickness (Figure 8.). The possible reason could be related to difficulties allied with uniform antireflection coating covering of the plate edge. If the plate covering is non-uniform or insufficient, the lowered scanning accuracy as well as data loss can occur.

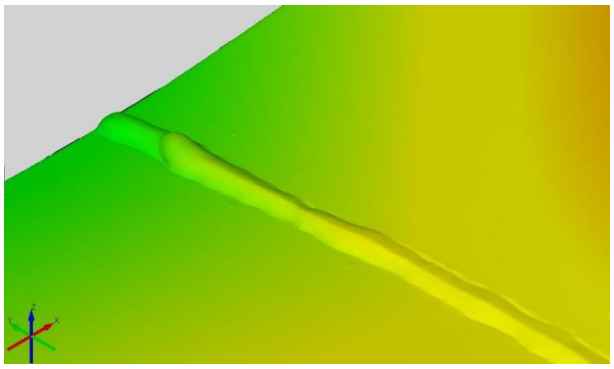

Figure 9. The weld bead connection close-up on weldment fabricated by manual GMAW

5. Conclusion

Obtained results confirmed that 3D optical scanning can be applied as an alternative method of weldment deformation measurement. Furthermore, the precision of used GOM *ATOS* II Triple Scan is sufficient also for characterization of surface weldment defects, e. g. bead reinforcement, weld undercuts, surface pores, residual surface slag, etc. The digital 3D model can therefore be used in quality control or verification of welding process simulation.

Acknowledgement

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INFLUENCE OF LASER BEAM WELDING PARAMETERS ON WELD JOINTS MICROSTRUCTURE OF DUPLEX STEEL

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Abstract
Duplex stainless steels are gradually ever more exploited also in transport and civil engineering. This is reasoned by their advantageous combination of high strength and good corrosion resistance. Welding of duplex steels with highly concentrated power sources has disadvantage in comparison to arc welding methods, since the structure of the weld metal consists mostly of ferritic component, what is a general characteristic for beam technologies, owing to a rapid cooling down, resulting to lower corrosion resistance. Solving the given issue of welding duplex stainless steels with highly concentrated power sources necessitates application of heat treatment (preheat and/or post heating). The paper deals with influence of specific heat input on austenite to ferrite ratio. The optical microscopy analysis and quantitative structure analysis were performed.

Keywords:
Laser beam welding, duplex stainless steel, microstructure

1. Introduction

Duplex stainless steels (DSS) belong to corrosion resistant steels grade. The name “duplex” describes phase composition in microstructure of the steel. This material contain approximately equal amount of ferrite and austenite what results to enhanced mechanical properties in comparison to standard austenitic steels [1].
This material is used in offshore industry as well as constructional industry. Because of their high strength they are widely used for constructing pressure vessels or pedestrian bridges.

Figure 1. Pressure vessel made of DSS [2]

Welding of these materials is well handled by the standard arc technologies. These technologies utilize the advantages of filler materials. The filler materials are nickel based alloys supporting austenite formation. Another benefit of arc technologies is relatively high heat input from the electric arc that allows the austenite to form and grow. Manufacturers of DSS recommend using 0.5 to 2.5 kJ/mm heat input [1].
In general, beam technologies are not recommended for welding because of the limited heat input which is much lower thanks to high concentration of energy into the small spot. This paper investigates the influence of heat input on phase composition of duplex stainless steel weld metal [1].
The research focused on protective atmosphere showed benefit in weld bead shape as well as weld surface and weld root appearance. Nitrogen was used as a shielding gas in order to raise austenite content. Ternary phase diagram showed that the nitrogen is widening the area of austenite formation, but significant changes were not observed during the laser welding.

2. Methods

Duplex stainless steel SAF 2205 with thickness of 2 mm was used for the experiment. The typical chemical composition of SAF 2205 is provided in Table 1. Almost equal phase ratio in microstructure is documented in Figure 2.

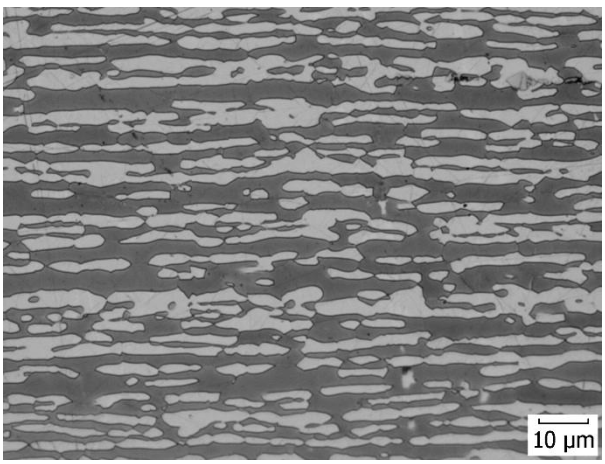

Figure 2. Microstructure of SAF 2205

Table 1. Typical chemical composition of duplex stainless steel SAF 2205 [3]

C [%]	Cr [%]	Ni [%]	Mo [%]	N [%]	Mn [%]	Cu [%]	W [%]
0.03	21-23	4.5-6.5	2.5-3.5	0.08-0.2	2.0	-	-

Workplace (Figure 3) consists of Fanuc 710iC-50 robot carrying the laser welding head Trumpf D70. Welding jig ensured the application of shielding gas to the weld root section during the welding process. The parameters of welding device are provided in Table 2.

Table 2. Welding device and process parameters

Laser source	Trumpf TruDisk 4002
Max. output power	2 kW
Focal distance	200 mm
Focal spot size	200 µm
Shielding gas	N2, 15 l/min

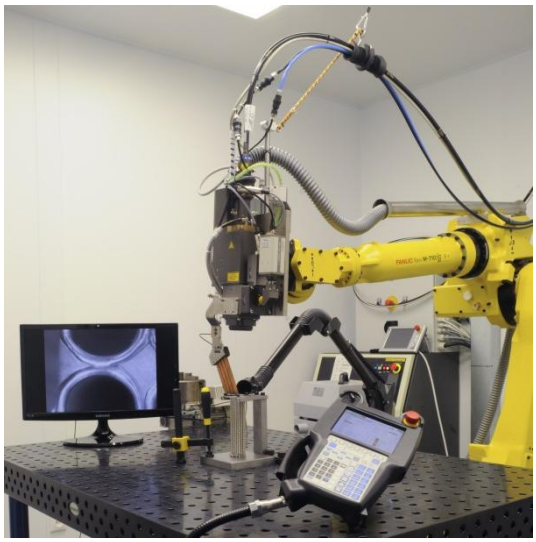

Figure 3. Laser beam welding workplace

Specimens for microstructural analysis were prepared by the standard metallographic procedure (grinding, polishing and etching). Neophot 32 optical microscope was used for microstructural observation.
Quantitative image analysis was performed on the micrographs taken from the weld bead in order to determine the volume fraction of ferrite and austenite. Determination of the phase volume fractions was done by the manual point count method on the micrographs taken at 400x magnifications, in accordance to ASTM E-562 standard. In order to obtain objective results 5 measurements were done on each weld metal. Measurements were realised in the middle of weld joint. Surface and root section may be slightly affected by the shielding gas since nitrogen promotes the austenite formation.

Together five specimens with different heat input were prepared in order to reveal the dependence of heat input on ferrite amount in the weld metal. Two parameters were changed during the experiment in order to maximise the heat input but preserve a reasonable weld bead appearance as well as the full penetration of the beam through the material. The parameters for each specimen are provided in Table 3. In each case the focus position was moved above the specimen surface to raise the heat input. Shielding gas flow rate was divided into two nozzles having same size. Shielding gas was delivered to material surface and to the root section. Higher heat input was not possible to apply due to the excessive weld bead width resulting to excessive surface concavity.

Table 3. Welding device and process parameters

Specimen No.	Heat input [kJ/mm]	Focus position [mm]
14A1	0.20	+5
14A2	0.18	+5
14A3	0.16	+4
14A4	0.14	+3
14A5	0.12	+3

3. Results

The focus position of laser beam had to be changed during the experiment in order to achieve full penetration weld. Regarding to this fact, as well as the fact that the heat input was changed, different weld shape was observed. Figure 4 illustrates cross-section of specimen 14A1 (highest heat input). Due to the high heat input, weld shape typical for LBW was not observed.

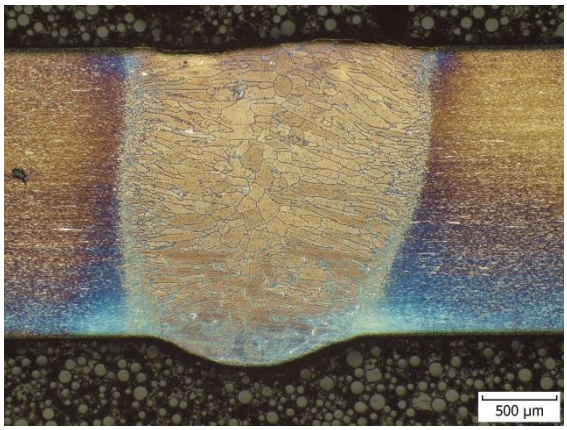

Figure 4. Cross-section of specimen 14A1

In all cases, surfaces of weld joints were smooth with regular weld bead and full penetration was achieved.
The specimens were prepared for microscopic analysis by standard methods of grinding, polishing and subsequently etched in Beraha's reagent for 3 seconds. Despite of short etching

time, the darker area appeared in micrograph due to long etching time [4].

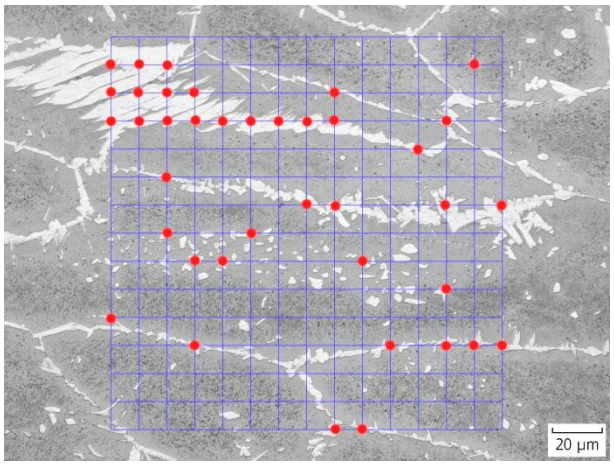

Figure 5. Cross-section of specimen 14A1

As mentioned in methodology, ferrite content was determined by the manual point count method on the micrographs as it is provided on Figure 5.
The results of point counting are shown in Table 3 and Figure 6.

Table 4. Measured amount of ferrite

Specimen No.	Heat input [kJ/mm]	Ferrite content
14A1	0.2	82.22
14A2	0.18	88.44
14A3	0.16	89.78
14A4	0.14	90.22
14A5	0.12	91.11

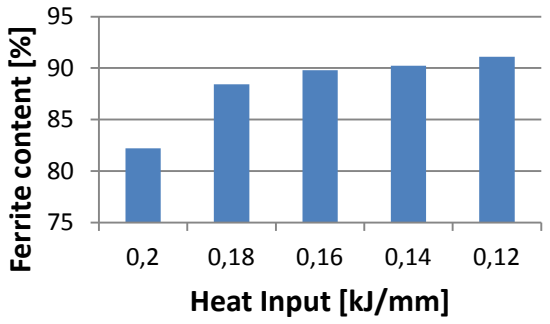

Figure 6. Cross-section of specimen 14A1

According to the presumption, ferrite content raised by lowering the heat input.

4. Conclusion

Nevertheless it is not possible to weld duplex stainless steel by standard laser welding by one pass. Produced heat input did not provide balanced ratio of ferrite and austenite.
Therefore I can be stated that simple laser beam welding is not suitable for welding thin sheets od duplex stainless steel. Maximum austenite content observed in weld metal was only 17.88 %. It can be concluded that nitrogen shielding gas did not support austenite enough to gain 50 % content in microstructure.
Further investigation will be focused on utilisation of technological movements to raise the heat input. Also the use of filler material containing higher amount of elements supporting austenite formation will be the subject for further research.

Acknowledgement

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EFFECT OF TEMPERATURE CHANGES ON THE FUNCTION OF THE ELECTRIC GUITAR

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Abstract

The appearance of new materials and technology provides the modern and comprehensive approach to the process of constructing and designing new products. The process of constructing in the history was limited by choice of available materials and technologies which are able to make products. Modern approach to constructing can be applied in the development of a completely new product or in analysis and redesign of existing products.

This paper analyzes design of electric guitar that dates back to the 50's of the last century. It analyzes the basic function of the product. The primary function of the electric guitar is making a sound by vibrating of wires with predefined frequencies. Strings on the guitar require prestressing to produces sound of proper frequencies.

The main lack of the existing design of the guitar, which is more than 60 years unchanged, is change of the preset frequency of strings with temperature change of the guitar parts. The change of temperature can stretch or shrink certain parts of the guitar including strings. Because of the different materials of the guitar neck and strings, shrinkage and stretching of the wires is not equal to the guitar neck. That causes a change in the tension of the wire, and hence the preset frequency. This paper analyzes change in frequency of strings depending on temperature change of parts of the guitar. Based on the analysis is proposed that the neck of the guitar should be manufactured from composite Verton UX03320 PPA. Temperature elongation of the proposed composite is equally to elongation of guitar strings. The newly proposed material can replace the maple tree that is commonly used for making the guitar neck.

Keywords:

guitar, temperature change, vibrations, new design

1. Introduction

This paper analyzes the design of product which was presented in the 50s of the last century and has remained nearly unchanged.

Figure 1 shows design of guitar which dates from 1954, which is today produced with the same technology and of the same material.

Figure 1. Electric guitar Fender Stratocaster in 1954 [1]

In the past 60 years there has been significant development of technologies and series of new materials in the market. Therefore, this paper seeks the application of new technologies and materials to correct the deficiencies of the old design. This paper analyzes one of the most functional deficiencies of the guitar, and that is change preset frequencies on the guitar with a change in the ambient temperature or the guitar.

2. Changes in the natural frequency of strings

The main task of this product is that the vibration of individual wire produce the appropriate frequency. Here comes one major disadvantage, which is that the temperature change uneven stretch or shrink strings and neck of the guitar. That causing a significant change in the frequency of strings vibration.

Strings on a guitar are made of steel and have a coefficient of linear expansion $\alpha_{string}=12\cdot10^{-6}$ K^{-1}. Neck of the guitar is made of wood (usually maple) and has a coefficient of linear expansion $\alpha_{neck}=5\cdot10^{-6}$ K^{-1}.

The calculation is performed to check the effect of temperature changes on the first natural frequency of the wire. As an input parameter for the calculation is taken temperature change ΔT=25 K.

Standard set of strings was taken for the calculation. Characteristics of strings are given in Table 1.

Necessary forces in the strings are calculated according to the formula:

$$f = \frac{1}{2l}\sqrt{\frac{F}{\rho}} \tag{1}$$

ie

$$F = 4l^2 f^2 \rho \tag{2}$$

-where is:

F – force in string, N
l – length of string, m
f – first natural frequency, Hz
ρ - mass of string per unit length, kg/m

Table 1. Strings diameter, natural frequencies of the strings on the guitar and necessary force to achieve these frequencies [2]

STRING	STRING DIAMETER mm	NATURAL FREQUENCY Hz	MASS PER UNIT LENGTH kg/m	TENSIONING FORCE N
E ili 1st	0,254	329,63	$0,401 \cdot 10^{-3}$	71,42
B ili 2nd	0,330	246,94	$0,708 \cdot 10^{-3}$	70,83
G ili 3rd	0,432	196,00	$1,140 \cdot 10^{-3}$	71,81
D ili 4th	0,660 (0,3556 core)	146,83	$2,333 \cdot 10^{-3}$	82,50
A ili 5th	0,914 (0,381 core)	110,00	$4,466 \cdot 10^{-3}$	88,58
E ili 6th	1,168 (0,4064 core)	82,407	$6,790 \cdot 10^{-3}$	75,64
			SUM	**460,78**

3. Calculation of change in frequency of the first wire - tone E4

The frequency of this tone is 329,63 Hz [3]. Length of the section of string between supports is 650 mm.
To achieve this natural frequency it is required to tighten string to the force of 71,42 N (Table 1).
Elongation of string during guitar tuning:

$$\Delta l_{tuning} = \frac{F \cdot l}{E \cdot A} = \frac{71{,}42 \cdot 650}{210000 \cdot \frac{0{,}254^2 \cdot \pi}{4}} = 4{,}36 \text{ mm} \quad (3)$$

Elongation of string due to temperature change of ΔT=25 K:

$$\Delta l_{temp} = (\alpha_{string} - \alpha_{neck}) \cdot \Delta T \cdot l = (12-5) \cdot 10^{-6} \cdot 25 \cdot 650 = 0{,}114 \text{ mm} \quad (4)$$

The force in the string after the temperature change (after warming up):

$$\Delta l = \Delta l_{tuning} - \Delta l_{temp} = 4{,}022 \text{ mm} \quad (5)$$

$$F = \frac{\Delta l \cdot E \cdot A}{l} = \frac{4{,}022 \cdot 210000 \cdot \frac{0{,}254^2 \cdot \pi}{4}}{650} = 65{,}84 \text{ N} \quad (6)$$

The first natural frequency after the temperature change:

$$f = \frac{1}{2l}\sqrt{\frac{F}{\rho}} = \frac{1}{2 \cdot 0{,}650}\sqrt{\frac{65{,}84}{0{,}401 \cdot 10^{-3}}} = 311{,}69 \text{Hz} \quad (7)$$

It is evident that the frequency of the first string decrease in frequency from 329,63 to 311,69 Hz with the change (increase) the temperature guitar for 25 K.
How big is this discrepancy can be concluded if we know that the next lower tone of tone E4 tone is D#4, which has a frequency 311,13 Hz [3]. This is a significant deviation from the initial tonality.
Results of E4 and the other strings frequency deviation are presented in Table 2.

Table 2. Change of guitar string tuned frequency depending on the change in temperature by 25 K

Desired tone	Frequency of desired tone	Natural frequency after temperature change	Frequency changes due to temperature change	Closest tone after temperature change
E4	329,60 Hz	311,69 Hz	17,91 Hz	D#4
B3	246,94 Hz	237,67 Hz	9,27 Hz	A#3
G3	196 Hz	186,16 Hz	9,84 Hz	F#3
D3	146,83 Hz	141,49 Hz	5,34 Hz	C#3
A2	110 Hz	105,62 Hz	4,38 Hz	G#2
E2	82,41 Hz	78,47 Hz	3,94 Hz	D#2

4. Proposed design changes

Effect of temperature change directly which influences on basic function of the product can be avoided by using appropriate material of guitar neck and body.
The redesigned guitar will be made of composite polymer material reinforced with glass fiber, which has a coefficient of linear expansion equal to that of steel.
This will ensure uniform elongation of the guitar neck and strings and the natural frequency of the strings will not change with temperature change.
For the neck and body of the guitar is chosen material Verton UX03320 PPA. Manufacturer of this material is SABIC Innovative Plastics [4]. Table 3 shows the properties of this material.

Table 3. Properties of composite Verton UX03320 PPA [5]

SABIC Innovative Plastics LNP Verton UX03320 PPA		
Categories:	polimer; plastomer; poliftalamid (PPA)	
Material Notes:	VERTON* UX03320 is a compound based on Polyphthalamide resin containing Long Glass	
Physical Properties		Comments
Density	1,63 g/cm^3	ASTM D 792
	1,63 g/cm^3	ISO 1183
Mechanical Properties		Comments
Tensile Strength at Break	200 MPa	ISO 527
	220 MPa	ASTM D 638

Elongation at Break	1,90 %	ASTM D 638
	1,90 %	ISO 527
Tensile Modulus	18,2 GPa	5 mm/min; ASTM D 638
	20,3 GPa	1 mm/min; ISO 527
Flexural Modulus	17,7 GPa	2 mm/min; ISO 178
	18,0 GPa	ASTM D 790
Flexural Strength	300 MPa	ASTM D 790
	360 MPa	2 mm/min; ISO 178
Izod Impact, Unnotched	8,00 J/cm 23,0°C	ASTM D 4812
Izod Impact, Unnotched (ISO)	70,0 kJ/m² 3,00 mm 23,0 °C	80*10*3; ISO 180/1U
Dart Drop, Total Energy	15,0 J	ASTM D 3763
	19,0 J	ISO 6603
Izod Impact, Notched	3,00 J/cm 23,0°C	ASTM D 256
Izod Impact, Notched (ISO)	38,0 kJ/m² 4,00 mm 23,0 °C	80*10*4; ISO 180/1A
Thermal Properties		Comments
CTE, linear, Parallel to Flow	12,0 µm/m °C -40,0 to 40,0 °C	ISO 11359-2
	12,0 µm/m °C -40,0 to 40,0 °C	ASTM E 831

5. Advantages of the new design

The analysed product was originally made of wood. The neck is maple wood and the body of the guitar is made of mahogany. Neck of redesigned guitar will be made of composite Verton UX03320 PPA In order to simplify creation of the guitar body and neck of the guitar will be made as one piece.

Due to musicians physical exertion and the transport is desirable to reduce the weight of the product. The strength of the composites is much higher than the strength of wood in the analyzed product. Therefore, the neck and body of redesigned guitar will be made of hollow cross section.

The product is necessary to construct such a way that it is at the end of life easily recycled.

Production of the body and the guitar neck should be manufactured by injection molding, which will in series production result in significant savings.

The main advantage of the new design is that the guitar does not change the frequency of strings according to the change ambient temperature.

6. Conclusion

This paper analyzes the design of electric guitars that dates back to the 50s of the last century. The main lack of the existing design of the guitar is change of the preset frequency of strings with temperature change of the guitar parts.

Analysis shows that the frequency of the first string (E4) decrease in frequency from 329,63 to 311,69 Hz with the change (increase) the temperature guitar for 25 K. Second string (B3) decrease in frequency from 246,94 to 237,67 Hz. Third string (G3) decrease in frequency from 196 to 186,16 Hz. Fourth string (D3) decrease in frequency from 146,83 to 141,49 Hz. Fifth string (A2) decrease in frequency from 110 to 105,62 Hz. Sixth string (E2) decrease in frequency from 82,41 to 78,47 Hz. This is a significant deviation from the initial tonality.

Effect of temperature change directly which influences on basic function of the product can be avoided by using appropriate material of guitar neck and body.

The redesigned guitar will be made of composite polymer material reinforced with glass fiber, which has a coefficient of linear expansion equal to that of steel.

This will ensure uniform elongation of the guitar neck and strings and the natural frequency of the strings will not change with temperature change.

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ANALYSIS OF WIND INFLUENCE TO STATIC STABILITY OF THE EAVE FRAMEWORK

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Abstract

Eave framework is analysed in this paper from standpoint of statics. Loads taken into account are self-weight, snow and wind influence. 3D model of eave framework is generated in the software PartSolution (Cadenas) with certain simplifications in geometry. Simplifications are taken into account in order to reduce costs of the numerical calculation, especially the FSI calculation. The resulting pressure distribution solution obtained from CFD calculation is set as the boundary conditions on the eave framework when performing the structural analysis. Solutions for equivalent stress as well as deformation are presented and analyzed. Also, solution for airflow prediction around the eave framework are presented in order to analyze if it is possible to perform some changes in the construction in means of reducing the air resistance and thus reducing the wind load on the construction.

Keywords:

Eave framework, wind influence, CFD, Computational Fluid Dynamics, FSI, Fluid – Structure Interaction.

1. Introduction

Freestanding eave frameworks serve as protection from the sun, rain, snow and other weather conditions. One of the most important loads, in addition to its own weight is a load of snow and wind. In most cases eave framework construction is made from steel while the tent is made from 100% polyacrylic whose characteristics is high strength, waterproof and antistatic to dust and atmospheric pollution. Some construction variation of eave framework can be seen in [1].

2. Geometry

The eave framework model is generated using PartSolution (Cadenas) software. Model is modeled in full details (Figure 1) including welds, screws, reinforcements etc., while simplified model is used for make finite element and CFD calculations (Figure 2). Basic dimensions of the construction are shown on Figure 3. From static point of view this is really simple model to solve, but it is quite hard to take into account wind influence, so the Fluid – Structure Interaction method was used to analyze wind influence to the eave framework.

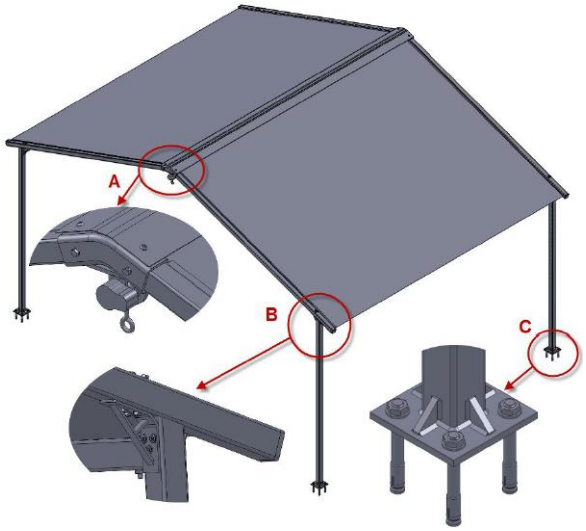

Figure 1. Full detailed model

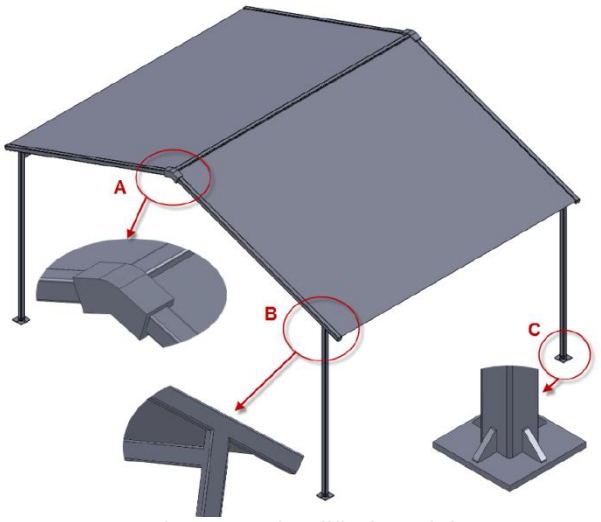

Figure 2. Simplified model

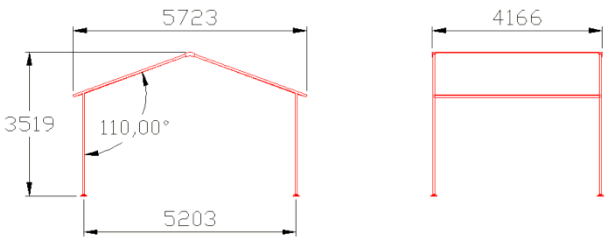

Figure 3. Basic dimensions of the construction

3. Load conditions

As mentioned earlier, besides of self-weight it is needed to include loads from snow and wind as the most dominant regarding to the structural stability. Snow loading can be calculated using (1):

$$s = s_k \cdot \mu_i \cdot C_e \cdot C_t \qquad (1)$$

where:

- s_k - characteristic snow load on the ground, (according to the Table 1. for altitude and Figure 4 for geographic location),
- μ_i - shape coefficient (depending on the type and slope of the roof), Table 2.,
- C_e - exposure coefficient which takes into account hard conditions of wind blowing (in most cases $C_e = 1$,
- C_t - temperature coefficient which takes into account thermal insulation of the roof (in most cases $C_t = 1$.

Table 1. Characteristic snow load on the ground

Altitude	s_k, kN/m^2			
	I	II	III	IV
0	0,88	0,75	0,14	0,18
100	1,09	1,05	0,45	0,33
200	1,31	1,38	0,80	0,50
300	1,55	1,76	1,20	0,70
400	1,80	2,18	1,65	0,92
500	2,06	2,63	2,15	1,16
…	…	…	…	…

Figure 4. Geographic location for characteristic snow load in the Croatia [2]

Table 2. Shape coefficient

Slope of the roof	$0° < \alpha \leq 30°$	$30° < \alpha < 60°$	$\alpha \geq 60°$
Shape coefficient μ_1	0,8	$0{,}8(60-\alpha)/30$	0
Shape coefficient μ_2	$0{,}8+0{,}8\alpha/30$	1,6	-

So according to the presented tables and figures and taking into account geographic location of the eave framework, Coefficients for this particular case are:

$s_k = 1{,}09$ kN/m^2
$\mu_i = 0{,}8$
$C_e = 1$
$C_t = 1$

And finally, snow load on the roof is:

$S = 0{,}872$ kN/m^2.

Wind loading is considered like quasi-static pressure acting perpendicular to the surface of the building. Besides that, there are special cases as tangential friction forces which are result of wind blow across long and flat surfaces. Characteristic pressure of wind is pressure of basic speed of the wind derived from basic fundamental value of wind speed [3]. Basic wind speed:

$$v_b = c_{dir} \cdot c_{season} \cdot v_{b,0} \qquad (2)$$

where:

- v_b - pressure of basic speed of the wind,
- c_{dir} - wind direction coefficient,
- c_{season} - season coefficient,
- $v_{b,0}$ - fundamental value of basic speed of the wind, Figure 5.

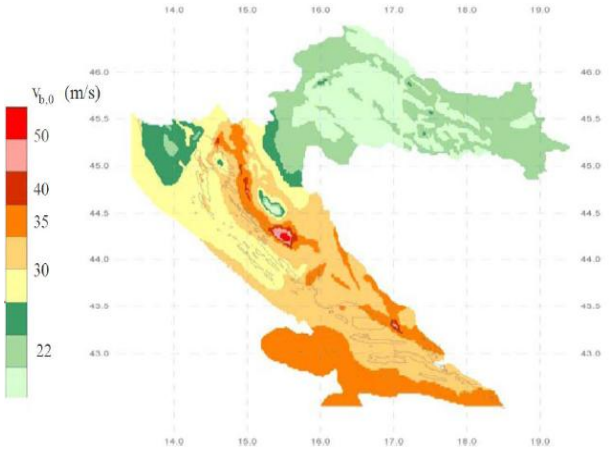

Figure 5. Fundamental value of basic speed of the wind [3]

If not otherwise specified, coefficients c_{dir} and c_{season} are taken with value 1 [3]. In that case $v_b = v_{b,0}$, and according to the Figure 4, $v_{b,0} = 25$ m/s. That speed is input value for further Fluid – Structure Interaction simulation.

4. Numerical calculation

Two separate calculations are performed, first one is eave framework loaded by self – weight and weight of the snow and the second one is eave framework loaded by the wind blow in most critical

direction. It is important to note that tent should not be stretched while snowing, so in numerical simulation it is stretched only to transfer snow load to the steel construction, so the tent is modeled from steel as well. Figures 6 and 7 shows deformation and stress distributions. As expected, deformation on the tent is large and that is reasonable, because of small thickness and large area of the tent. There are few local positions of large stress values, but that is negligible because those positions are only local stress concentrations.

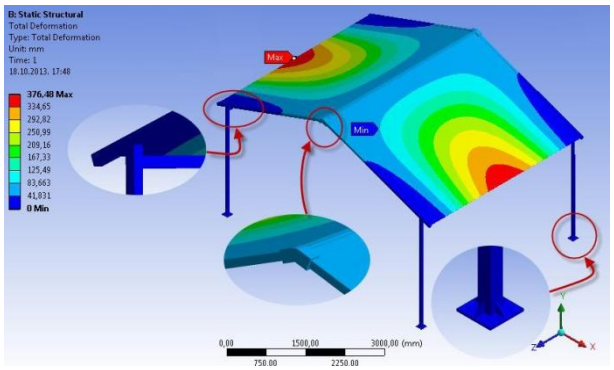

Figure 6. Equivalent deformation distribution, mm

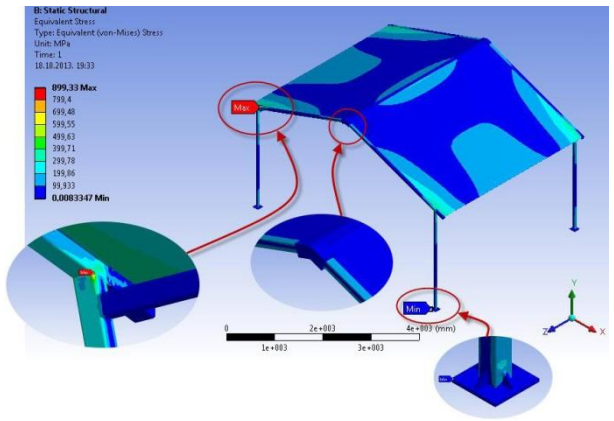

Figure 7. Equivalent stress distribution, MPa

The second case of numerical calculation is FSI. Wind influence is even more important influence to the stability of the construction, especially when wind speed is very large. In our case wind speed is 25 m/s and temperature is set with value of 25 °C. Figure 8 shows the domain of the numerical FSI simulation (30000 mm x 14000 mm x 10000 mm).

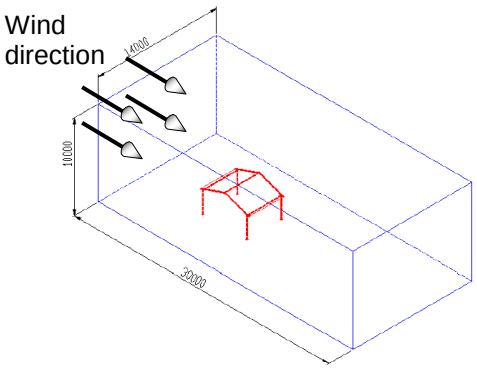

Figure 8. Dimension of the domain, mm

Figure 9 shows finite volume mesh with some details of structured mesh around the construction. Structured mesh around the geometry is important because It is known that in the boundary layer that occurs when the air flows around a body, there are large gradients of physical quantities, what requires filling of that area with smaller volumes, as opposed to areas away from the body. It should be the best to use as fine geometric mesh to cover the smallest wavelengths and thus small time steps to cover the highest frequencies. On that way, the accuracy of the numerical solution should be very high [4, 5, 6].

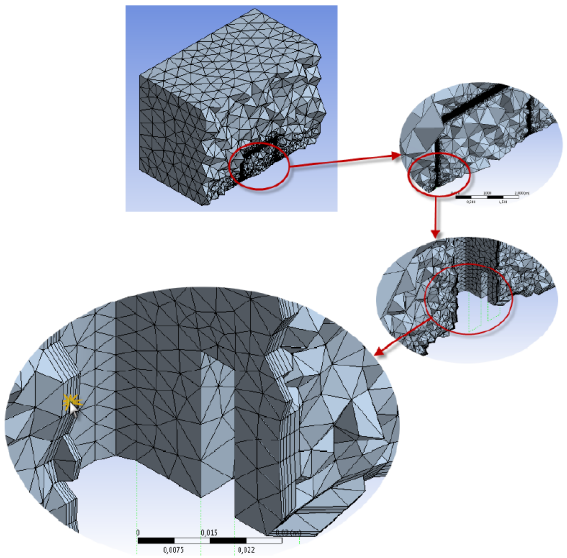

Figure 9. Finite volume mesh

FSI simulation implies two separate simulations, first one is Computational Fluid Dynamics (CFD) simulation to solve the pressure distribution on the construction, and the second one is static structural simulation where the pressure distribution from CFD is input loading parameter to the construction. Figure 10 shows pressure distribution obtained from CFD simulation.

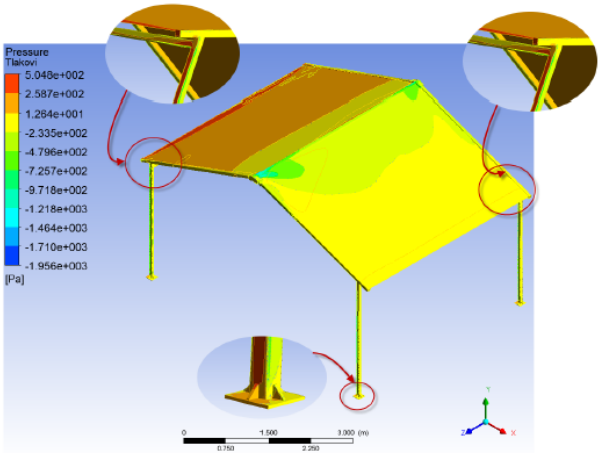

Figure 10. Pressure loading obtained from CFD, Pa

Figures 11 and 12 shows deformation and stress distributions caused by wind.

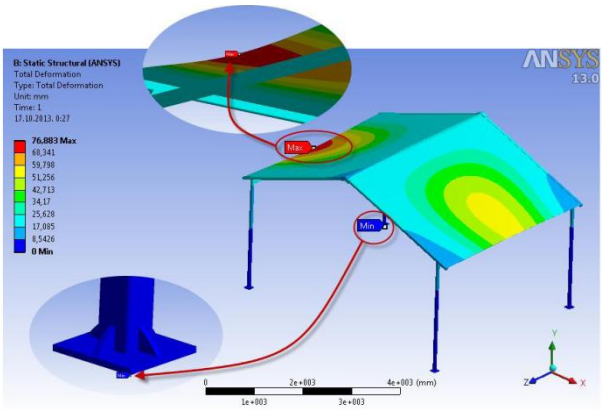

Figure 11. Equivalent deformation distribution, mm

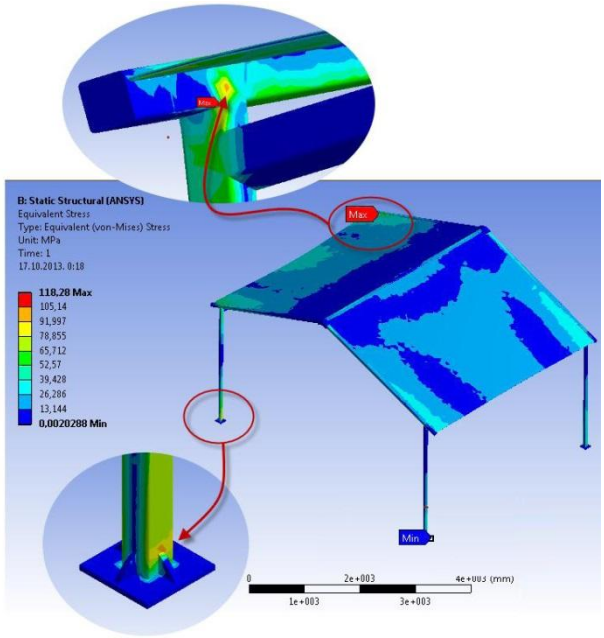

Figure 12. Equivalent stress distribution, MPa

As in earlier case, deformation on the tent is large and that is reasonable, because of the same reasons as in first case of calculation. There are also few local positions of large stress values, but that is negligible because those positions are only local stress concentrations.

6. Conclusion

Eave framework is numerically analysed in two cases, first one is eave framework loaded with self – weight and weight of snow and the second one is loaded with the wind speed of 25 m/s. In both cases there are large deformations on the tent, but the tent is not the vital part of the construction, in our cases it is only very important to transfer the loading to the construction. So in order to simplify the calculation tent is modeled from steel.

Regarding stresses, in both cases of the calculations, there are large amount of the stresses, but those are only on local small areas and has a local character representing only the stress contractions which has no influence on the structural stability of construction. It is important to note also that there are some stiffeners in the model (Figure 1) which additionally contribute to the strength of the framework so it can be concluded that eave framework satisfies from standpoint of strength.

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SPENDING BALL OR ROLLER BEARINGS DEPENDING ON HOW THE ROTATION AND SHAPE OF THE LOAD

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Abstract
Bearings are among the most important components of the vast majority of machines, and fully justified request to increase their carrying capacity and reliability. The desire of every company has approximately assess longevity of bearing in the facility for his timely changes. Because if the bearing does not change in time can lead to major damage to the facility. For longevity bearing affects a lot of factors, and this paper describes an important factor, and people often neglect it. It is the work of bearing under load in contact with the surface, where there is a creation of rolling bearing ball tracks which greatly affects the lifetime roller bearing.

Keywords:
roller bearings, load, damage

1. Introduction

Bearings are among the most important components in the vast majority of machines and exacting demands are made upon their carrying capacity and reliability[1]. Therefore it is quite natural that rolling bearings should have come to play such a prominent part and that over the years they have been the subject of extensive research. Indeed rolling bearing technology has developed into a particular branch of science.

Among the benefits resulting from this research has been the ability to calculate the life of a bearing with considerable accuracy, thus making it possible to match the bearing life with the service life of the machine involved. Unfortunately it sometimes happens that a bearing does not attain its calculated rating life. There may be many reasons for this - heavier loading than has been anticipated, inadequate or unsuitable lubrication, careless handling, ineffective sealing, or fits that are too tight, with resultant insufficient internal bearing clearance.

Each of these factors produces its own particular type of damage and leaves its own special imprint on the bearing. Consequently, by examining a damaged bearing, it is possible, in the majority of cases, to form an opinion on the cause of the damage and to take the requisite action to prevent a recurrence.

2. Path patterns and their interpretation

When a rolling bearing rotates under load the contacting surfaces of the rolling elements and the raceways normally become somewhat dull in appearance. This is no indication of wear in the usual sense of the word and is of no significance to the bearing life. The dull surface in an inner or outer ring raceway forms a pattern called, for the purposes of this paper, the path pattern. This pattern varies in appearance according to the rotational and loading conditions. By examining the path patterns in a dismantled bearing that has been in service, it is possible to gain a good idea of the conditions under which the bearing has operated.

By learning to distinguish between normal and abnormal path patterns there is every prospect of being able to assess correctly whether the bearing has run under the proper conditions. The following series of figures illustrates normal path patterns under different rotational and loading conditions (figures 2.1-2.7) as well as typical patterns resulting from abnormal working conditions (figures 2.8-2.14).

In the majority of cases the damage to the bearing originates within the confines of the path patterns and, once their significance has been learned, the appearance and location of the patterns prove to be useful aids in diagnosing the cause of the damage [2].

Deep groove ball bearings and thrust ball bearings have been used for illustrative purposes as they display such characteristic path patterns.

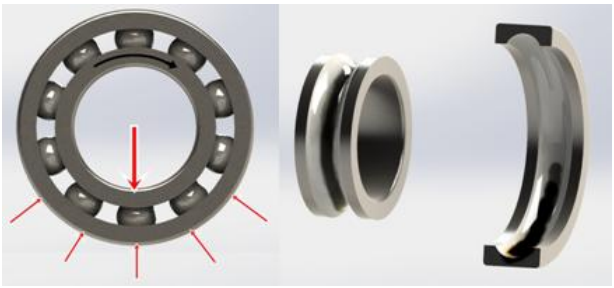

Figure 2.1 Uni-directional radial load

Rotating inner ring - fixed outer ring.

Inner ring: path pattern uniform in width, positioned in the centre and extended around the entire circumference of the raceway.

Outer ring: path pattern widest in the load direction and tapered off towards the ends.
With normal fits and normal internal clearance, the pattern extends around slightly less than half the circumference of the raceway.

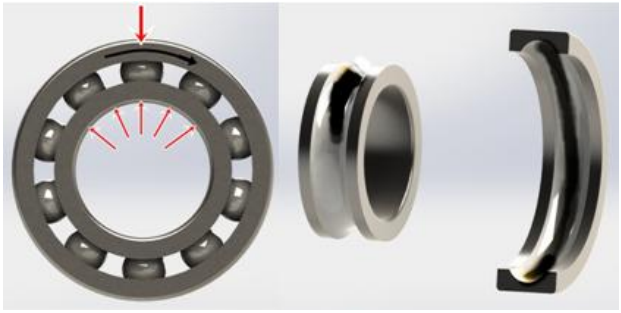

Figure 2.2 Uni-directional radial load

Fixed inner ring - rotating outer ring.
Inner ring: path pattern widest in the load direction and tapered off towards the ends.
With normal fits and normal internal clearance, the pattern extends around slightly less than half the circumference of the raceway.
Outer ring: path pattern uniform in width,positioned in the centre and extended around the entire circumference of the raceway.

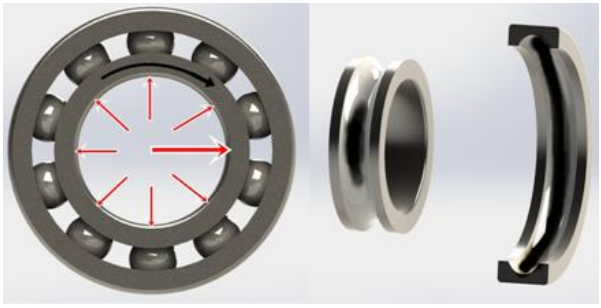

Figure 2.3 Radial load rotating in phase with the inner ring

Rotating inner ring -fixed outer ring.
Inner ring: path pattern widest in the load direction and tapered off towards the ends.
With normal fits and normal internal clearance, the pattern extends around slightly less than half the circumference of the raceway
Outer ring: path pattern uniform in width, positioned in the centre and extended around the entire circumference of the raceway.

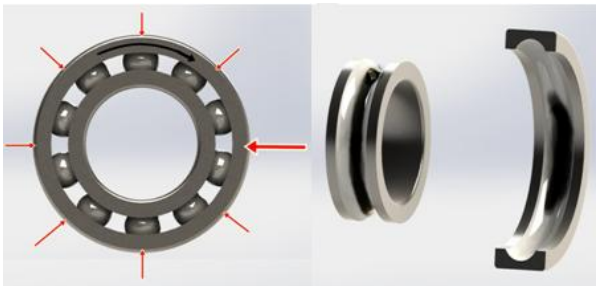

Figure 2.4 Radial load rotating in phase with the outer ring

Fixed inner ring - rotating outer ring.
Inner ring: path pattern uniform in width, positioned in the centre and extended around the entire circumference of the raceway
Outer ring: path pattern widest in the load direction and tapered off towards the ends.
With normal fits and normal internal clearance, the pattern extends around slightly less than half the circumference of the raceway.

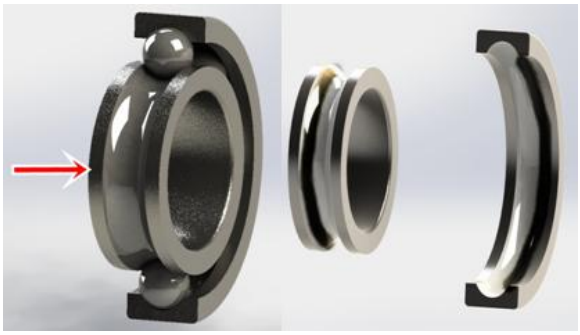

Figure 2.5 Uni-directional axial load

Rotating inner or outer ring.
Inner and outer rings: path pattern uniform in width, extended around the entire circumference of the raceways of both rings and laterally displaced.

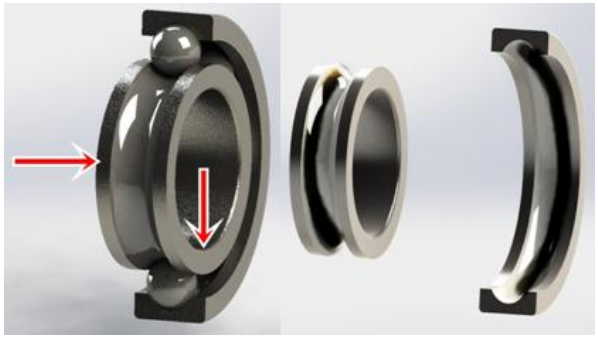

Figure 2.6 Combination of uni-directional radial and axial loads

Rotating inner ring - fixed outer ring.
Inner ring: path pattern uniform in width, extended around the entire circumference of the raceway and laterally displaced.
Outer ring: path pattern extended around the entire circumference of the raceway and laterally

displaced. The pattern is widest in the direction of the radial loading.

Figure 2.7 Uni-directiorial axial load

Rotating shaft washer - fixed housing washer.
Shaft and housing washers: path pattern uniform in width, extended around the entire circumference of the raceways of both washers.

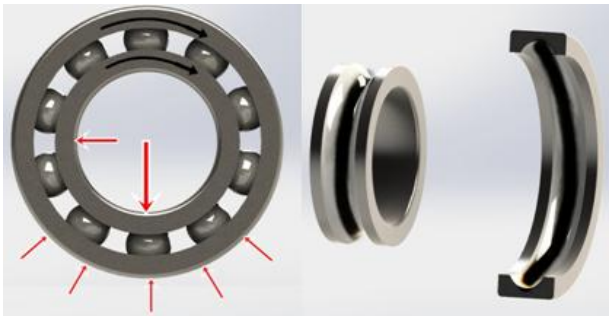

Figure 2.8 Uni-directional radial load + imbalance

Rotating inner ring - creeping outer ring.
Inner and outer rings: path pattern uniform in width, extended around the entire circumference of the raceways of both rings.

Figure 2.9 Fits too tight - preloading and uni-directional radial load.

Rotating inner ring - fixed outer ring.
Inner ring: path pattern uniform in width, positioned in the centre and extended around the entire circumference of the raceway.
Outer ring: path pattern positioned in the centre and extended around the entire circumference of the raceway. The pattern is widest in the direction of the radial loading.

Figure 2.10 Oval compression of outer ring

Rotating inner ring -fixed outer ring.
Inner ring: path pattern uniform in width, positioned in the centre and extended around the entire circumference of the raceway.
Outer ring: path pattern positioned in two diametrically opposed sections of the raceway. The pattern is widest where the pinching has occurred.

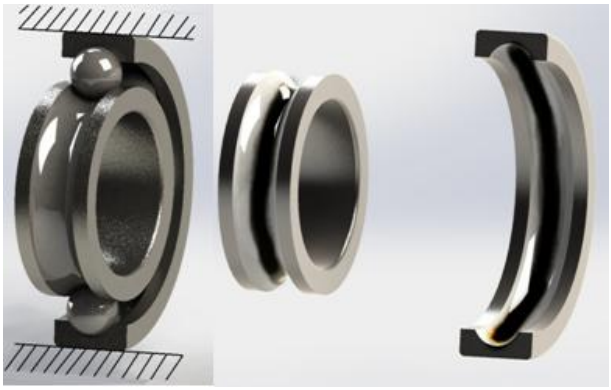

Figure 2.11 Outer ring misaligned

Rotating inner ring - fixed outer ring.
Inner ring: path pattern uniform in width, positioned in the centre and extended around the entire circumference of the raceway. Outer ring: path pattern in two diametrically opposed sections displaced diagonally in relation to each other.

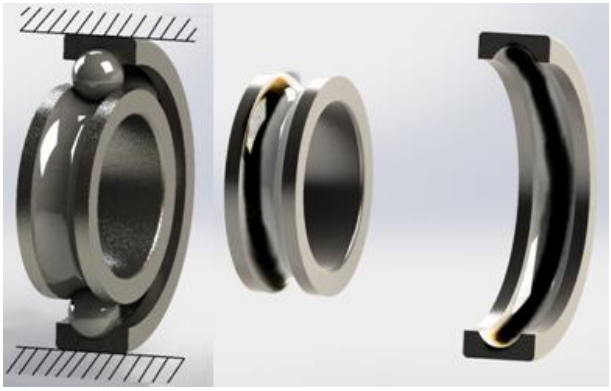

Figure 2.12 Inner ring misaligned

Rotating inner ring - fixed outer ring.
Inner ring: path pattern in two diametrically opposed sections, displaced diagonally in relation to each other
Outer ring: path pattern widest in the load direction and tapered off toward the ends.
The internal clearance is reduced on account of the misalignment of the inner ring; the length of the path pattern depends upon the magnitude of the internal clearance Reduction.

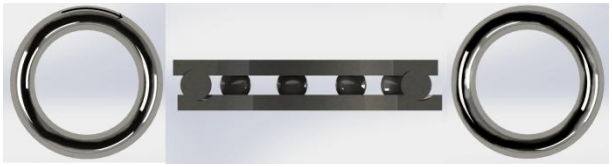

Figure 2.13 Housing washer positioned eccentrically relative to shaft washer

Rotating shaft washer-fixed housing washer.
Shaft washer: path pattern uniform in width, extended around the entire circumference of the raceway.
Housing washer: path pattern extended around the entire circumference of the raceway and off-centre relative to raceway.

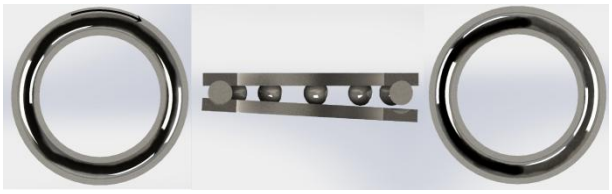

Figure 2.14 Housing washer misaligned

Rotating shaft washer - fixed housing washer.
Shaft washer: path pattern uniform in width, extended round the entire circumference of the raceway.
Housing washer: path pattern in the centre of the raceway but wider around part of its circumference.

3. Conclusion

Roller bearings are one of the most important machine elements because they allow keeping the moving machine parts such as axles and shafts. [3] They are inserted into appropriate housing. They consist of an inner and outer ring (or plate with axial bearings), between which the rolling bodies. How are they wearing part of the machine has to pay special attention to their lubrication, cleanliness, method of installation and the conditions in which they work, because they are one of the more precise parts of machine elements. This paper describes the ways in which bearings are spending at different mode of attachment and load, we can also see the harm of bad installation bearings. He must therefore pay particular attention during the installation of the bearing.

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INFLUENCE OF GEOMETRY OF PRESSURE VESSEL NOZZLE CONNECTION ON STRESS INTENSITY FACTOR

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Abstract
The main objective of this paper is the numerical analysis and assessment of stress concentration in nozzle connection area of one pressure vessel used in petrol industry. The pressured vessel geometry was modeled in 3D modeling software and then model was used for determination of stress concentration factor using finite element method. Solution convergence was carried out to determine the optimal mesh density, and then the numeric calculation is performed using varying different geometry parameters of pressure vessel and nozzle connection. The results are processed and results are presented in form of diagrams.

Keywords:
Stress concentration factor, pressure vessel, geometry, finite element method

1. Introduction

Pressure vessels are very common in mechanical engineering industry as well as other industries and they are essential for functioning of many aspects of modern civilization such as water supply systems, power plants, chemical plants to transportation and storage of various media. Pressure vessels have a wide range of applications, and consequently, a wide range of shapes, type of connections, performance and service conditions. Each case brings with it a number of factors to keep in mind when designing pressure vessel. Special care should be taken into account considering selection of pressure vessel material, exhibited strain and stress concentrations which can, for badly designed or constructed vessels, lead to catastrophic failures. Each pressure vessel contain cutouts, i.e. connections, including nozzles. Connections to pressure vessels, although necessary for the operation are the main source of the stress concentration. Their shape, position and relative position and distance affect the stress distribution and concentration.

For proper design of pressure vessels different standards are available that prescribe a number of required parameters necessary for safe and smooth operation. Until the appearance of suitable software packages and computers with sufficient processing power, stresses are mainly determined analytically, and some problems were often solved by analytical methods. Problems of stress concentration around the nozzles provided a major challenge to engineers because of volume and weight of such analyses. Nowadays software for stress analysis using finite element elements can be effectively used [1-3]. Thus, this method in combination with three-dimensional modeling is used in this paper to evaluate stress concentrations in connection of body and nozzle of one pressure vessel used in petrol production industry. This evaluation is not done just for one geometry, but three of variables are systematically varied (wall thickness of cylindrical part of pressure vessel, wall thickness of nozzle and inner diameter of pressure vessel) keeping outer diameter of pressure vessel constant.

2. Stress concentration factor

In the vicinity of the sharp transitions or at the place of action of concentrated forces the distribution of stresses is not uniform. Maximum stress can be many times greater than the average i.e. nominal stresses. This phenomenon is called stress concentration [4]. This stress increase is defined with stress concentration factor as ratio of maximum stress and nominal stress:

$$K = \frac{\sigma_{\mathrm{m}}}{\sigma_{\mathrm{n}}} \tag{1}$$

where K is stress concentration factor, σ_{m} is maximal stress (in this paper maximal von Mises stress and maximal principal stress σ_1 are considered giving two stress concentration factors K_{VM} for von Mises stress and K_{P} for maximal principal stress) and σ_{n} is nominal stress [3].

Nominal stress is further expressed for cylindrical pressure vessel [5]:

$$\sigma_{\mathrm{n}} = \frac{p \cdot (D_{\mathrm{a}} - e_{\mathrm{n}})}{e_{\mathrm{n}}} \tag{2}$$

where p is pressure inside pressure vessel, D_a is analytical diameter of pressure vessel and e_n is thickness of wall of cylindrical part of pressure vessel.

3. Modeling and finite element analysis

Before any numerical analyses geometry of pressure vessel is checked according European norm EN 13445 [5] and it was found that it complies this standard. Outer dimensions of pressure vessel considered in this paper is shown on the Figure 1.

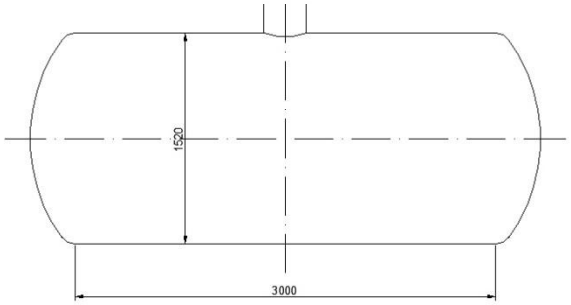

Figure 1. Geometry of pressure vessel

Three-dimensional model of pressure vessel is modeled in SolidWorks [6] neglecting other nozzles that have any significant influence on stress distribution where maximal stress occurs, because they are located far enough, in order to simplify model. Since it was planned to study of influence of wall thickness of cylindrical part of pressure vessel (e_n), wall thickness of nozzle ($e_{n,b}$) and inner diameter of nozzle (d_b) (Figure 2) on stress concentration, producing larger number of models needed to analyze the problem (27 models) was needed.

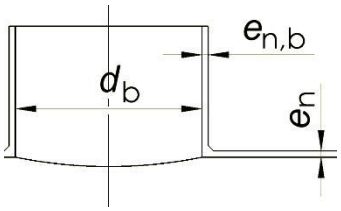

Figure 2. Variables for analysis

Considered variables and their values are shown in Table 1.

Table 1. Variables for finite element analysis

e_n, mm	$e_{n,b}$, mm	d_b, mm
8	8	250
10	10	300
12	12	350

Due to convenience models of pressure vessels are designed as one parametric model in SolidWorks using the module for variables. After, simply by changing the variables the software generates needed models. Figure 3 shows the entire model and Figure 4 shows one eighth of model prepared for numerical analysis to take advantage of symmetry of the analyzed problem.

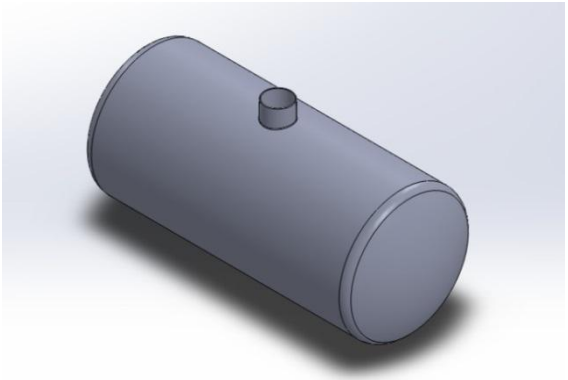

Figure 3. 3D model of pressure vessel

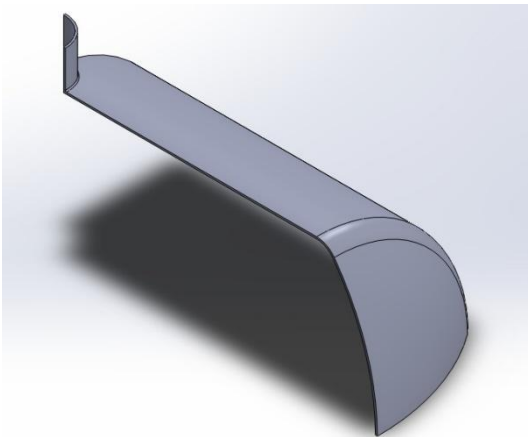

Figure 4. 1/8 of model of pressure vessel

For finite element analysis, ANSYS software is used [7]. Due to geometry of pressure vessel, firstly due to welded connection, a 20-node brick elements in combination with tetrahedral 10-node elements are used in finite element analyses. The mesh was scaled in order to get smaller elements in place of interest (connection of nozzle to cylindrical wall of pressure vessel) and larger elements on area of no special interest for this analysis (Figure 5 and 6).

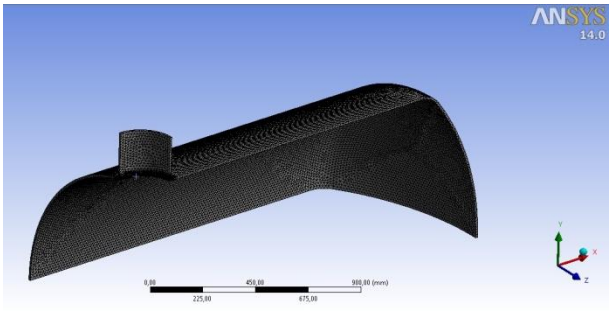

Figure 5. Finite element model of pressure vessel

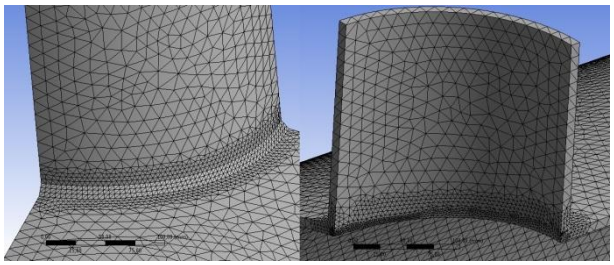

Figure 6. Finer mesh in connection of nozzle to pressure vessel

To determine optimum number of elements and element size preliminary solution convergence is done. Increasing number of finite elements, solution for stress distribution is observed and when difference in maximal stress was not significantly increased with increase of number of element (decrease in element size) gave model with optimum number of finite element for obtaining accurate results. In this case models had 100.000-110.000 elements producing difference in results less than 0,5 % than model with 130.000 elements.

All models had the same thickness of the weld between the nozzle and the cylindrical portion of the pressure vessel of 8 mm and mechanical properties of material P355GH were assigned to the weld as well as the rest of pressure vessel. Material was defined as linear-elastic with Poisson ratio of 0,3. Pressure vessel was subjected to inner pressure of 4 bar and axial force on end of nozzle corresponding to inner pressure and area of nozzle opening (Figure 7).

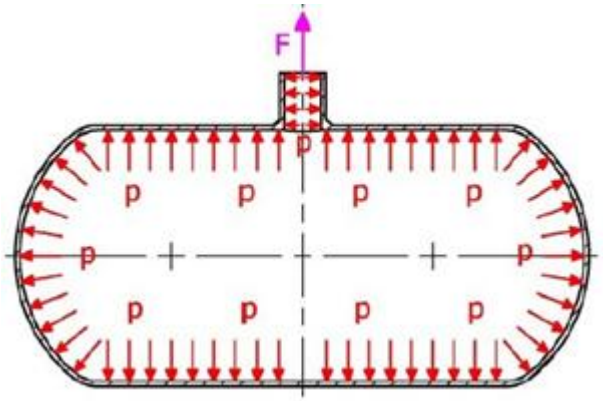

Figure 7. Load of pressure vessel

As results of analyses maximal principal stress and maximal equivalent von Mises stress are obtained. The values of the maximal principal and the equivalent von Mises stress of model with nozzle were compared with the nominal stresses obtained by models without connection in order to determine the stress concentration defined by stress concentration factor.

4. Results

With finite element analysis, stress distribution is obtained for all models. It can be noted that maximal values of equivalent von Mises stress as well as maximal principal stress are on same place (Figures 8, 9, 10 and 11).

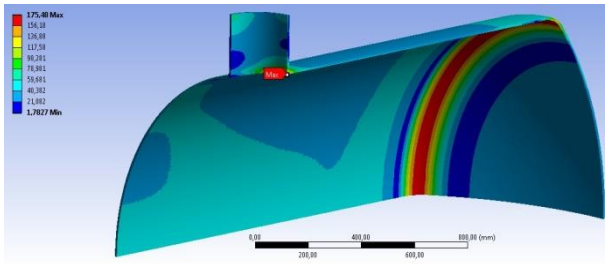

Figure 8. Equivalent von Mises stress distribution, MPa

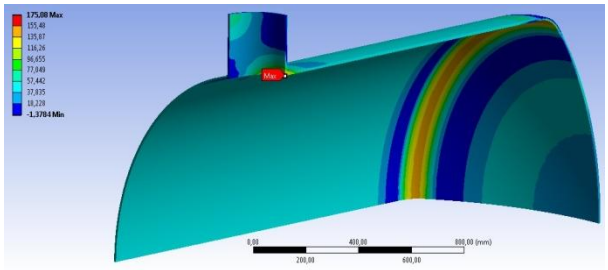

Figure 9. Principal stress distribution, MPa

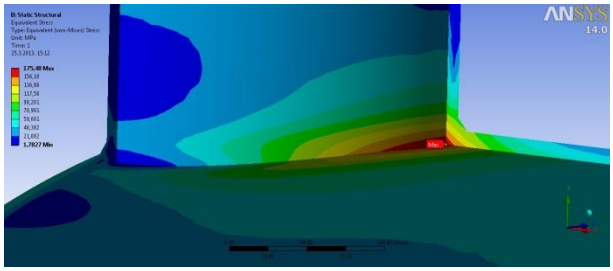

Figure 10. Equivalent von Mises stress distribution, MPa - detail of place where maximal equivalent von Misses stress occurs

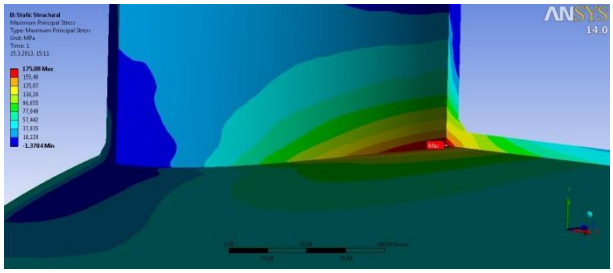

Figure 11. Equivalent maximal principal stress distribution, MPa - detail of place where maximal value of maximal principal stress occurs

There is very small difference between maximal principal stress and von Mises stress values for all analyzed models. Those values are divided with nominal stress and stress concentration factors are obtained for all models. These results are presented in form of diagrams using Statistica

software [8] for statistical analysis. Dependence of K_{VM} and K_P on nozzle thickness and inner diameter of nozzle is shown while pressure vessel wall is kept constant in order to determine which parameter has influence on stress concentration and is that influence small or significant.

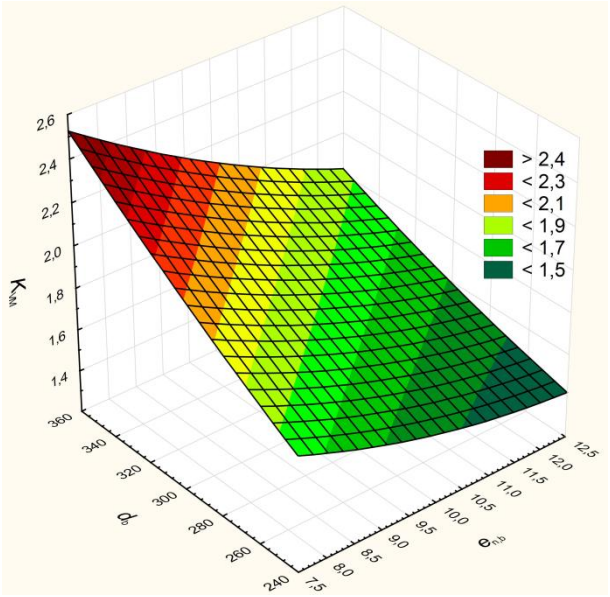

Figure 12. Stress concentration factor K_{VM} with constant e_n = 8 mm and changing $e_{n,b}$ and d_b

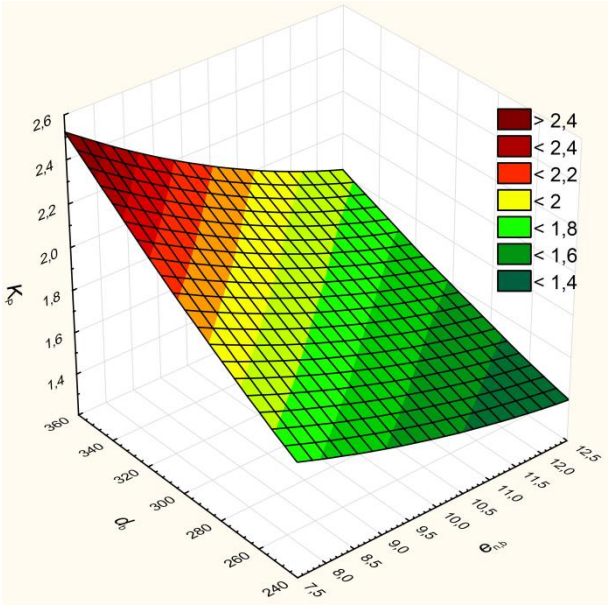

Figure 13. Stress concentration factor K_P with constant e_n = 8 mm and changing $e_{n,b}$ and d_b

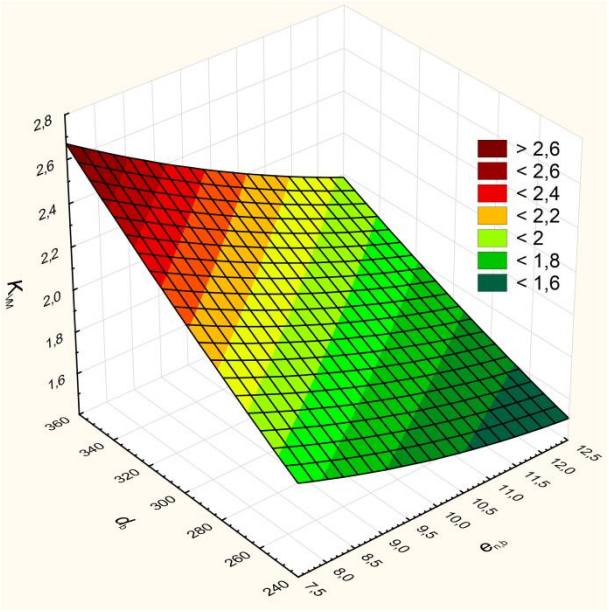

Figure 14. Stress concentration factor K_{VM} with constant e_n = 10 mm and changing $e_{n,b}$ and d_b

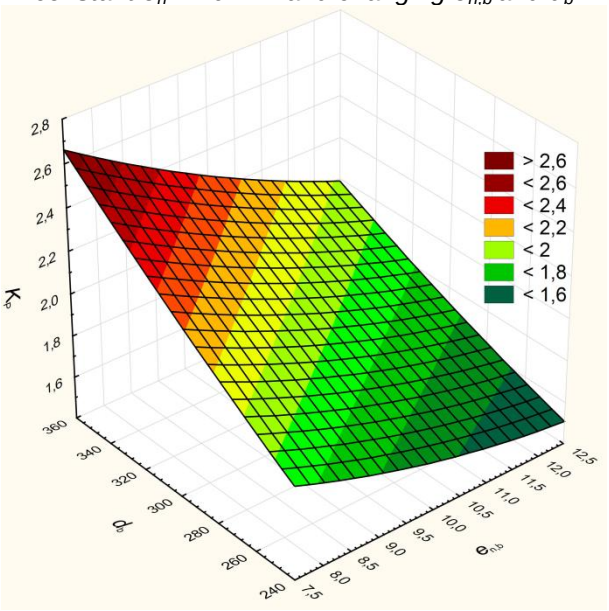

Figure 15. Stress concentration factor K_P with constant e_n = 10 mm and changing $e_{n,b}$ and d_b

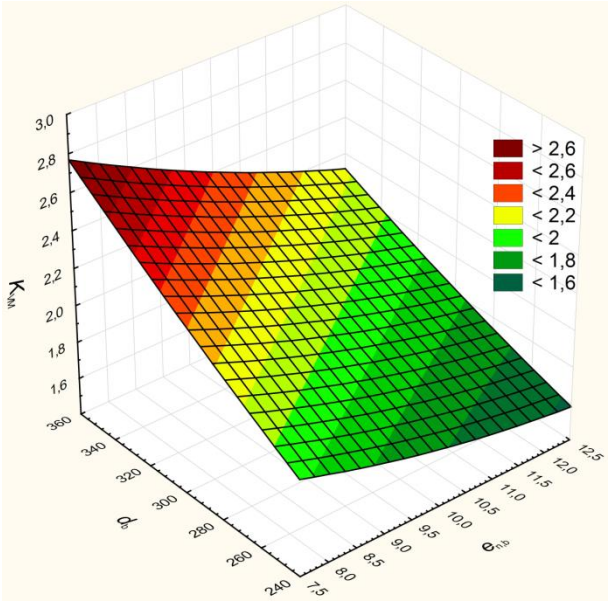

Figure 16. Stress concentration factor K_{VM} with constant e_n = 12 mm and changing $e_{n,b}$ and d_b

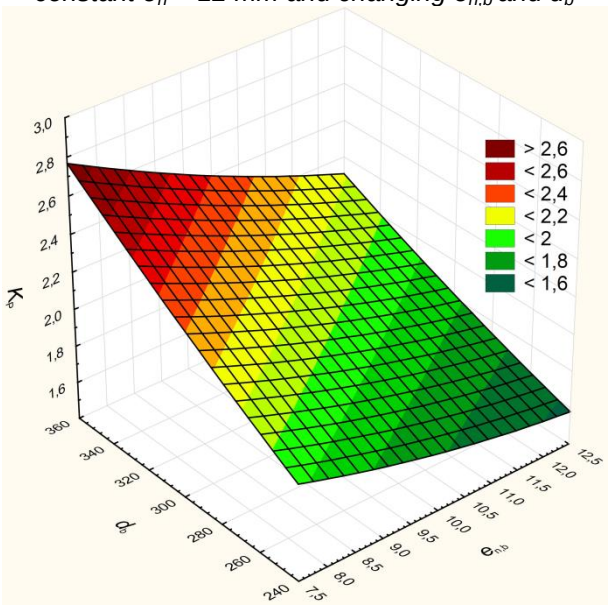

Figure 17. Stress concentration factor K_P with constant e_n = 12 mm and changing $e_{n,b}$ and d_b

It can be seen that wall thickness (e_n) of cylindrical part of pressure vessel has very small influence on stress concentration factor for this geometry because all values of K_{VM} and K_P are very close considering just change of this variable. Wall thickness of nozzle $e_{n,b}$ has significant influence on stress concentration factor for all geometry in such manner that increase of wall thickness leads to decrease of stress concentration factor. The most significant influence of considered parameters on stress concentration factor has inner diameter of nozzle d_b. Its increase leads to increase of stress concentration factor.

6. Conclusion

The analysis of 27 different models of pressure vessel to nozzle connection gave an overview of the influence of different geometrical parameters (wall thickness of the cylindrical part of pressure vessel, wall thickness of the nozzle and the inner diameter of the nozzle) on stress concentration within the pressure vessel. Analysis of results, obtained by finite element analysis, shows that the largest impact on the increase of the stress concentration for this geometry and type of connection at selected values of the parameters has increase of nozzle diameter, smaller impact has decrease of wall thickness of the nozzle and the decrease of pressure vessel wall thickness have a small but noticeable impact.

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INVESTIGATION POSSIBILITIES OF DELAMINATION AT DRILLING OF COMPOSITE MATERIALS

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Abstract
Today, composite materials are becoming more widely use in industries than aerospace or automotive industry. These are the sectors of industry, where is big importance of the productivity and accuracy. However, at the machining of composite materials raises some problem. One of these problems is delamination, which arises at drilling. This aim of the article is to compare the delamination testing methods, from industrial application aspect and accuracy of the delamination determination aspect.

Keywords:
delamination, composite materials, drilling, 3D scanning

1. Introduction

Composite materials or composites are constructive materials made of two or more components with significantly different physical and chemical properties. A new material is created with the combination of these components. Therefore unique properties can be exclusively assured by summarization of these components [2].

Physical properties of basic material and fibre are completely different. Physical properties and fibre orientation determine cutting power and machining conditions of composite material.

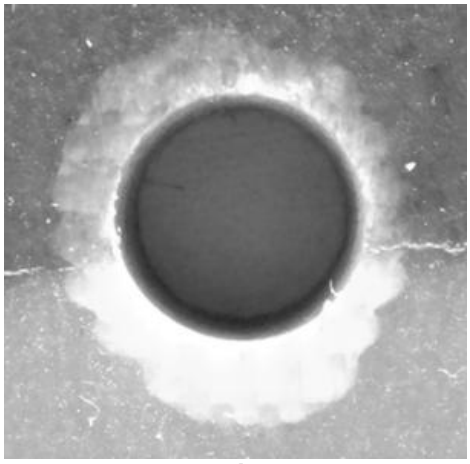
Machining of glass-reinforced composite with tool made from material, which is under polycrystalline diamond in the Moh's hardness scale (e.g. cemented carbide, carbide of silicon, boron carbide), wears more intensively.

It is possible to machine glass-reinforced composite on standard machine tool for metal or wood. Machining conditions don't require cooling but siphon off powder and chip.

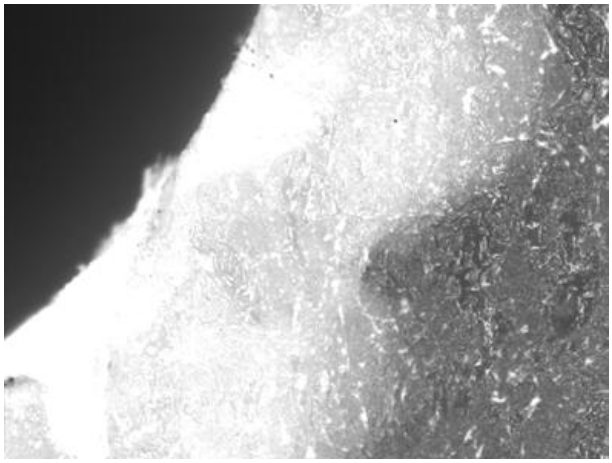
Since composites' heat resistant is low (100 - 300 °C), cutting conditions should be determined not to reach the critical temperature.

At machining the conductive is not the chip, but the machining tool. Therefore heat is conducted by the tool, which leads to tool wear. It is advised to use cemented carbide tools with high quality coat or diamond (PCD) [2].Composite materials are rarely useable without any mechanical machining process. During of machining (mainly milling) of these materials, so called delamination is formed (presented on Figure 1.). Delamination is separation and detachment of layers in material.

This phenomenon reduces the material life, therefore it causes serious problem. Analysis is many times difficult in industrial conditions.



a)



b)

Figure 1. Delamination presented on macro shot (a) and in 80x magnification (b)

During the machining of polymer composites have a lot of attendants (problems). On the Fig. 2-4 we can see some attendants.

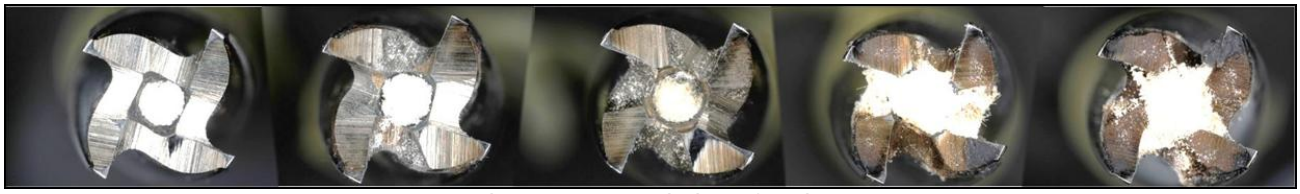


Figure 2. Degradation of resin

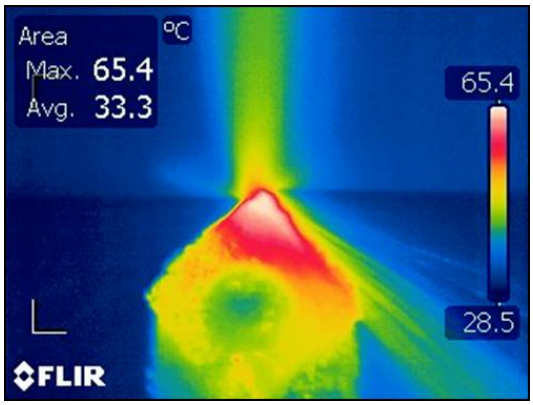


Figure 3. Cutting Temperature

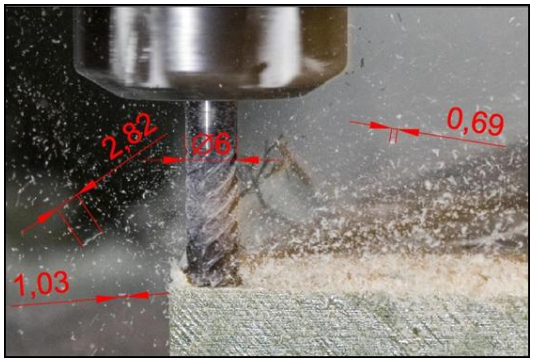


Figure 4. Chip removing and breaking

We analyzed research methods for this phenomenon and tried to find an effectively applicable method in practice during our research.

2. Description of experiments

We tested three variable material during experiments: a carbon fibre material (CFRP) plate, a glass fibre material (GFRP) plate and so-called sandwich plate, which is completed from one honeycomb structure embedded to two Kevlar layers.

We made five holes on each sheet, with variable feed rates during the drilling.

We tested delamination occured in material, in these holes by three variable methods and we compared results from the aspect of accuracy and usability in production.

Figure 5. Tested materials

Testing methods are following:

- Definition of delamination on the base of diameter,
- definition of delamination on the base of area calculation,
- definition of delamination on the base of CAD model created by 3D scanning.

The first method was determining of delamination on the base of diameter. For investigation we use digital microscope Mitutoyo QV 302. We used the software of image processing software, where we searched the biggest diameter of delamination bounder in material. We added this diameter to characteristic diameter for delamination, created on the edge of the hole and the damage was characterized by the ratio of nominal diameter of the hole.

The rate of delimitation is F_{D1} (F_{D1}), which can be calculated by formula (1).

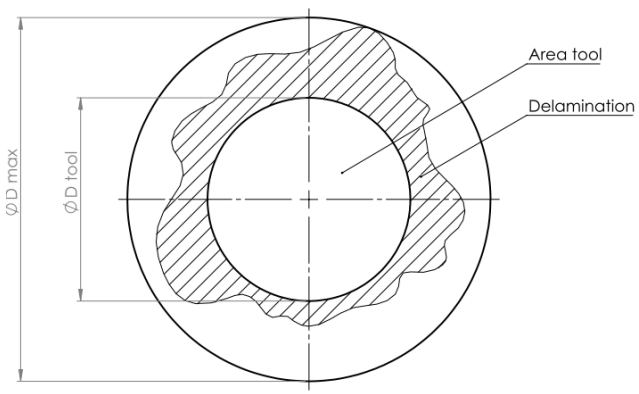


Figure 6. Determination of delamination on the base of diameter

$$F_{D1} = \frac{D_{max}}{D_{tool}} \quad (1)$$

when F_{D1} is delamination factor, D_{max} is the delaminated diameter and is D_{tool} the diameter of hole.
The second version gives more accurate results than the first method.
Technique of method, based on the diameter does not give sufficiently accurate picture about real extent of delamination.
At definition on the base of area calculation we used the same digital microscope Mitutoyo QV 302, as at the previous method. We determined the delamination according to the area of damage.
We took up a cloud of points on the outer edge of the damaged area, in the software of image processing system. Then, by the cloud of points coordinates through software Matlab we determined the area of damaged part of material, by calculating integral.
We characterized the final delamination as a quotient of the received area and the nominal area of hole.
The extent of delamination (F_{D2}) can be calculated by formula (2).

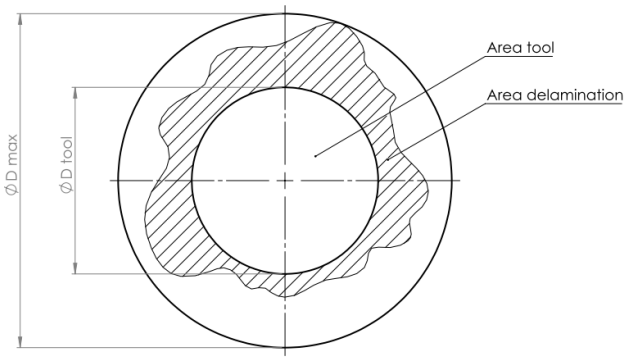


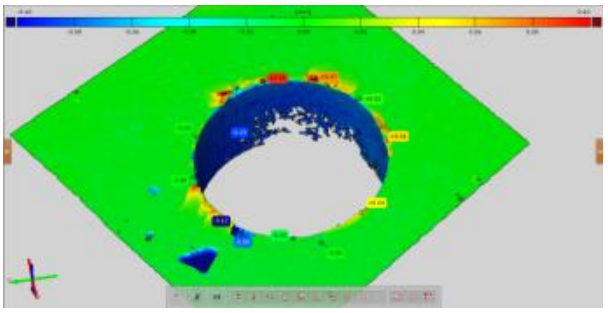
Figure 7. Determination of delamination on the base of measuring of area

$$F_{D2} = \frac{A_D}{A_H} \quad (2)$$

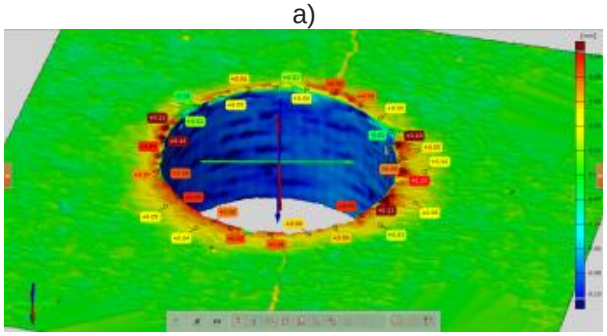
when F_{D2} is delamination factor, A_D is the delaminated surface and is A_H the area of hole.
In practise, we seek to converge this value to 1 course, it depends on technological settings.
We used the following syntax in software MATLAB for calculating of the area and delamination:

```
x=[x1 xn…x1];
y=[y1 yn…y1];
Area=trapz(x,y);
R=5.4;
Drill=pi*R^2;
Delamination=Area/Drill;
Area
Delamination
```

The third method, which we examined, is the most precisely from these three methods. It is despite the fact that it does not provide numerical value about degree of delamination.
We created a high precision CAD model from tested holes by the help of high-resolution 3D scanner (*GOM ATOS II TripleScan SO MV38*). The we evaluated the model by the help of software GOM Inspect.
Result of the test is a three-dimensional colour picture (so called colour deviation map, presented of Figure 8.), where each the colour deviation map represents the deviation between the digitized part and CAD model.



a)



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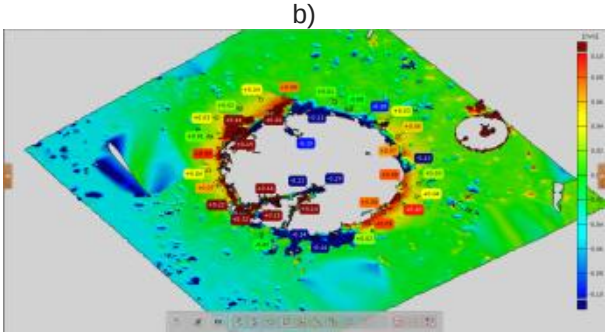

c)

Figure 8. Definition of delamination on the base of CAD model created by 3D scanning

Table 1. Technological parameters used at drilling and rate of delamination at each materials

No. of measurents	v_c [m/min]	f [mm/rev.]	v_f [mm/min]	D_{tool} [mm]	Material	F_{D1}	F_{D2}
1	52	0,02	51,9	6,38	GFRP	1,20	1,36
2	52	0,04	103,8	6,38	GFRP	1,29	1,69
3	52	0,08	207,6	6,38	GFRP	1,32	2,11
4	52	0,12	311,3	6,38	GFRP	1,43	2,02
5	52	0,24	622,7	6,38	GFRP	1,46	2,16
6	52	0,02	51,9	6,38	CFRP	1,05	1,09
7	52	0,04	103,8	6,38	CFRP	1,06	1,13
8	52	0,08	207,6	6,38	CFRP	1,07	1,15
9	52	0,12	311,3	6,38	CFRP	1,10	1,21
10	52	0,24	622,7	6,38	CFRP	1,12	1,25
11	52	0,02	51,9	6,38	Sandwich	1,11	1,22
12	52	0,04	103,8	6,38	Sandwich	1,06	1,12
13	52	0,08	207,6	6,38	Sandwich	1,21	1,42
14	52	0,12	311,3	6,38	Sandwich	1,25	1,51
15	52	0,24	622,7	6,38	Sandwich	1,19	1,43

Table 2. Comparison of measuring methods

Measuring method	Point of view				Σ
	Precision	Economy	Productivity	Automatiozaton	
F_{d1}	2	4	4	4	14
F_{d2}	4	4	3	4	15
CAD comparison	5	2	2	3	12

3. Conclusion

During the experiments was found that final result of test based on CAD model provides more data, than tests based on diameter or area calculating.
The drawback of the method is, that is slower than other two methods. It can be because the analysis of the microscopic images can be arranged by the help of image recognition softwares.
In our opinion, from economic, productivity and accuracy aspects the most effective method in production is method based on the area calculating (Table 2).

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APPLICATION OF VIBRO METHODS IN PRACTICE FOR REDUCTION OF RESIDUAL STRESSES

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Abstract
The aim of this work is to describe a method that can be used as an alternative to thermal processing. The vibration method with the help of sub-resonant frequencies to the object aims to reduce residual stresses and secure dimensional stability of the object. Practical application of the method is shown through several examples where the treatment is applied. The advantages and drawbacks of sub-resonant frequencies are reviewed on the basis of recorded results showing reduced resonant frequencies as well as comparisons with residual stresses in the structure/construction before and after the vibration process.

Keywords:
Vibration, residual stress, welding

1. Introduction

Historically, the method the stress relief through vibration started in the 1950's when the US navy as well as the German army applied harmonic vibrations (dubbed resonant vibrations) for testing metal of ship hulls and aeroplane wings.
Later they tried to decrease the application of heat treatment for stress relief and increase the applicaton of the vibration method. However, when resonant vibrations were to used to alleviate the stress the results were irradic and inconsistent. Due to such results engineers developed the method and found that the secret to successful stress relief relies on 2 factors:

1. The vibration of the metal in the sub-resonant zone and
2. Monitoring of the resonant frequency

The process removes residual stresses caused by rapid heat treatment with the application of mild vibrations at sub-resonant frequencies on to metal components.
In the interest of optimal application of the method on to a certain component the origin of the residual stress and deformation will also be explained in this paper. It also necessary to know to which materials this method can be applied.

2. Vibration in general

Vibration treatment during or post-welding decreases the chance of brittle fractures by introducing high energy amplitudes in to the object with the help of low vibrations. The most effective vibrations are resonant being that resonant frequencies are distributed better when compared to sub-resonant frequencies. The vibration frequency is increased until the resonant frequency of the object is found. In theory, the object must not be suspended at that frequency for risk of tearing so the treatment frequency must be lower than the resonant. In turn, the maximum amount of energy intake is achieved without comprimising the object in question. The process is quick, clean and very energy efficient. The process was conceived as an applicable tool by staff and adaptable to most production environments. It can also be transported within the workplace or used in the field. The vibration device introduces high and low amplitude vibrations in certain time intervals in to the treated object depending on its' weight. In turn residual stress is released without deformation, altered fibre strength, protraction and altered resistance to fatigue. Low frequency vibrations carry high amplitudes of energy and are very efficient in the significant reduction of residual stresses in metal pieces and weldings. Vibro equipment can also be fitted with a recording device which can be used to produce charts/graphs. It takes approximately 2 minutes to achieve resonant resonant frequency. When needed resonant frequency is achieved the vibrations are retained for a certain period of time. This can last anywhere from 10 minutes to as long as an hour or even more. In the event of prolonged retention the piece in question will not suffer from fatigue or loss of strength. If the treated piece is very large, long or contains an open space the process may need to be applied at more than a single area. Some equipment have the option of automatically applying vibration. Vibrations are maintained up to 15 minutes in succession with 3 different chosen frequencies each lasting 5 minutes. This method is favourable for the treatment of pieces weighing up to 10 tonnes. For all pieces heavier than 10 tonnes it's possible to apply the method in two 15 minute periods consecutively without any damage to the piece. For the application of this method there are 2 rules that need to be followed:

a) Optimal placement of the piece, isolation from the floor or any other hard structure leaving it free to vibrate.
b) The vibrator need to be directly connected to the piece so that all of the vibrational energy is transferred.

The method can be applied to a broad spectrum of coloured metals including carbon and stainless steel, cast iron, aluminium, titanium and etc. as well as a wide variety of shapes. Size may vary from small welded pieces, axles/swivels and cogs to large welded and mechanical steel constructions. One of the most important advantages of the vibration method is its' ability to relieve stress at any given moment of the production process as well as post production such as drilling or grinding. The method can be applied during welding which is convenient since residual stresses that cause bending can be prevented.The method is compatible particularly with REL, MAG and TIG welding methods while with other methods problems may emerge.

Recommended application of the vibro method

1. Before rough treatment
2. Before final production
3. Before quenching or heat treatment
4. Before EDM cutting
5. Before quality control, before the components are put in service
6. As preventive maintenance, components are in service
7. During welding-„Meta-Lax Weld machine“
8. After welding repairs
9. Always before deformation and/or fractures

Workpieces that can be subjected to the vibrational stress relief method:

1. Plates, rods, cylinders, structural shapes, etc.
2. Welded joints
3. Casts
4. Forged workpieces
5. Extruded workpieces

Application of the vibrational stress reduction method during welding is possible on all alloys and commonly results in a smoother, better ductility, longer lifespan, less contraction deformation, less fractures in heat treated areas and faster welding time.

To ensure maximum effect stress relief is recommended before any production process whatsoever where certain mistakes are foreseeable.

The list of materials not recommended for the vibrational stress reduction method due to stability tests of the machine:

1. Cold-formed steels including rolled steel plates, sheets, and hard to straighten pieces
2. Edges of heat treated plates
3. Copper and copper alloys.

3. Equipment description

The vibrational stress relief device META-LAX series 2700-CC is comprised of: the console, the inductor, the adjustor and stop key, rubber isolation pads, clamps, probes, the computer.

The console - connects the inductor and the computer and is used to manage (adjust) the vibrational process.

Figure 3.1 Console [2]

The inductor - is controlled via the console which is connected to the computer and induces vibrational energy in to the workpiece. The amount of force is dependent on the force used by the inductor, eccentric weight settings on 1F, 1FD, V8, 2A, 3A.

Specific duration cycles are recommended to maximize the lifespan of the bearings and the inductor motor. The inductor must work 1-8 hours after which it must cool down with an operational capacity of 1-4 hours at 50Hz.

1F 2A

Figure 3.2 Inductors 1F, 2A [2]

The adjustor and stop key - Inductors V8,2A and 3A come with adjustor and stop keys that allow the operator choose the settings for eccentric weight. The settings primarily depend on the flexibility of the workpiece. In general, more flexible pieces need lower eccentric settings while rigid pieces demand higher eccentric settings.

Figure 3.3 Adjustor and stop key [2]

Rubber isolation pads - The workpiece including components, platform table, clamps etc. must be „vibrationally isolated“ from the environment. High density rubber pads (60 durometers) are used for

this purpose. These pads are placed under each of the corners of the workpiece. Extremely long or extremely flexible workpieces may require an additional set of pad under the mid section of the workpiece.
The clamps - In order for the inductor to vibrate any workpiece it must be tightly fastened to the workpiece. The clamps serve this purpose. A minimum of 900 kg of force per clamp is necessary for a 2A inductor or weaker with a minimum of 1800 kg of force per clamp for a 3A inductor.

Figure 3.4 Clamps [2]

The probe is an electromagnetic device that records sagging of the workpiece caused by vibrational energy induction in time. The probes produce minute signals proportionate to the scale of the sagging in the workpiece (amplitude). The console receives the amplified signal and is used to calculate the resonant peaks of the curve. The exact frequency at which the workpiece is treated is determined by the aforementioned curve. During the process the amount of energy transmitted on to the workpiece by the inductor is maintained at an optimal level for stress relief or welding depending on the work method. The probe must be placed horizontally or almost vertically in relation to the workpiece. The position of the probe must never be perfectly vertical.
The probe cables connect the probe to the console - The clamp connects the probe to the workpiece in any direction however the probe must never be placed vertically.

Figure 3.5 Probe, cable probe and clamp [2]

4. Vibration process administration

Clamps are needed to place the inductor on to the surface we wish to treat. The inductor must be placed on a horizontal surface but can be placed on vertical surfaces. Placement on horizontal surfaces ensures clearer readings via a vertically placed probe.
Avoid placing the inductor on thin walls of the workpiece but rather on thick walls, delicate surfaces must be protected beforehand.
After the motor has been placed the inductor motor needs to be kept cold as well as isolated with isolation pads. The relief process can be summed up in six steps. The application consists of preliminary structural dynamic analysis with the goal of setting parameters for vibrational relief treatment as well as analysis of the possible application of available equipment. Preparation of the areas for vibro relief signal measurement and their placement. Placement of the inductor followed by monitoring the relief process. Finally, there is post-process data analysis gathered from measurement devices after the process. After the vibrorelief device has been placed a resonant frequency must be found after which the values are set to 1/3 less than the resonant hight of the curve for A class material. Whereas B and C values should be kept from 1/3 to ½ under the resonant frequency.

Table 4.1 Material classification table [2]

Material	Class	Including
Low-carbon steels, hot rolled	A	1018, 1020,A36
Medium-carbon steels	A	1045,1060
Low-carbon steels	A	4620,8620
Medium-carbon steel alloys	A	4140,4340,H13,P20
Casted iron	A	Silver, nodular
Aluminium	A	2000's,5000's,6000's,356
Tool steels	B	D2,A2,M1,M2,M3, M4
Steels with high toughness/temper	B	HY-80,HY-100
Stainless steels	B	304,316,410,416,
Precious metals	B	Titanium, magnesium gold
Powder metals and high tough metals	C	Carbide

Workpiece isolation- rubber high density pads are needed to isolate the workpiece.
These pads are placed under every corner of the workpiece. In the event that you want small pieces, axles or cylinders are subjected to the same method. They are put on to the „sandwich plate“ where they must be tightly fastened to the centre of the „sandwich plate“ so the vibrations transferred to the workpiece achieve maximum effect.

Attachment rod- the attachment rod is used in moments when the workpiece has an offset longer than 450mm.
Probe assembly- The probes are mounted 1m from the inductor however they mustn't be placed directly above the rubber pads. The probes must placed in a horizontal or vertical position as they give the best results.
Inductor assembly- Placement of the inductor relies on the geometrical characteristics of the construction as well as the dynamic analysis beforehand through which indicators of energy flow and expected echoes are established. There are four factors that determine the placement of the inductor:

1. Eccentric weight settings
2. Number of inductor locations
3. Base direction of the inductor
4. Installation surface [2]

Figure 4.2 Use of the 2A inductor for surface protection under the coupling [2]

Figure 4.3 2A inductor application [2]

Figure 4.4 Application of vibro device during welding [2]

Figure 4.5 Vibrating a segment of a 120 tonne transport machine

5. Vibro method and conventional heat treatment method comparison

The vibro method has several advantages over heat treatment. [3]

Table 5.1 Vibro method and heat treatment comparison

Advantages	Vibro method	Heat treatment
Efficiency	excellent	excellent
Durability	excellent	excellent
Documentation	excellent	good
Application during welding	possible	partially
Application on finished products	yes	yes
Object size constraints	no	yes
Application to smooth surfaces	no	Yes
Application time	short	prolonged
Material distortion	no	no

Advantages of the vibro method:

- Simplicity of use and maximal accuracy
- Easy to carry and compact equipment with the possibility of application on the field
- Less fractures during welding
- Faster welding
- Less deformations
- No dimensional constraints
- Improvements to the characteristics of weld couplings (better micro-structures, granularity of the weld)
- Less heat induction
- No need for subsequent heat treatments
- - Best results with braced constructions (easily acheivable resonant frequencies)

Disadvantages of the vibro method:

- If the construction is rigid then resonant frequency cannot be achieved
- Relatively unknown and not applicated

6. Conclusion

In the last 60 years this method has developed from a relatively unknown area to a respectable basic process that has been established as an alternative to heat treatment of casts, pieces requiring additional mechanical processing and non-metal materials. It's important to mention that the vibro method is not an alternative to all heat treatments but there are areas where these methods are and will be in the future prodominant.

Heat and vibration treatment cover three areas; stress reduction, dimensional control and dimensional stabilisation. Eventhough complete offloading of residual stress is impossible via application of any commercial method, the vibro method can stabilise and deformationally disburden a component during any mechanical or productional phase with or without effecting the change of the metallic state of the material without distortion at a low cost and little time required.

The vibration process includes bringing one or many metallic structures to a resonant or sub-resonant state by applying high power boosters.

Research shows energy conservation with the vibration method in some cases even 500:1.

The vibration process can be applied during and and after welding. The effects of reduced residual stress are anywhere from 20% to 95% according to a wide spectrum of research [4].

The vibration method can be used to stabilise masses of congruent elements before mechanical processing and exploitation as an alternative for stress reduction via anealling.

The vibration method is used to reduce residual stress and stabilise sizes of various weld couplings for instance machine frames, casts from silver casts and so on that until now have been treated by annealing to reduce stress. This method does not negatively effect the static-dynamic strength of the weld coupling and weld, break and impact toughness and homogeneity of welded couplings.

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USING OF SIMULATION PROGRAMS FOR THE INJECTION MOLDING

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Abstract
Polymeric materials processing is one of the fastest growing industries in the world. One of the most important method for processing polymeric materials is injection molding. The characteristics of the process (mass production of wide variety of products from very simple one to extremely demanding, the possibility of achieving high productivity with very little or no additional finishing operations), make it a very interesting and important cyclical polymeric materials processing procedure. A large number of injection molding parameters affects the performance and productivity of molding part. By using modern programs to simulate the filling of the mold cavity is possible to anticipate problems that may occur during polymer melt flow into the mold cavity which greatly reduces the time required for the construction of polymeric products or injection mold. The paper describes computer simulation of filling mold cavity and the calculation of injection molding parameters for selected polymeric part.

Keywords:
Injection molding, injection molding simulations, moldflow

1. Introduction about injection moldings

Injection moulding is one of the most common processes used to produce plastic parts. It is a cyclic process of rapid mould filling followed by cooling and ejection. A variety of materials both plastic and non-plastic can be used as feedstock. However, the machine must be configured for the type of material used. The material, which is generally available as grains or powder, is plasticised in an injection unit and injected into a clamped mould under high pressure (500-1500 bar). The main advantage of injection moulding is that it is a very economical method of mass production.

Ready parts with tight tolerances can be produced in one step, often completely automatically. In general after-processing is not necessary. It is also possible to integrate different functions into one part to avoid the formation of different components that would be more expensive, e.g., the base of a typewriter with integrated guidance and fixing elements, the springy components of a printer element, a lens with integrated prisma to stop down a beam of light. [1]

It is worth noting that 75 % of faults in the lifetime of injection moulded polymer parts are initiated in the process of developing and designing the parts. Moreover, in the conventional product development process, approximately 80 % of faults generated during early phases of product design are recognized during production or quality control (Fig. 1). In the later development process phases, it is very difficult and costly to correct these faults. This means that during product development process it is necessary to make correct decisions, and make them as soon as possible. [2]

To guarantee a high quality in the injection moulded parts the following points have to be considered: [1]

a) The material has to be plasticised and injected carefully to avoid negative effects on the material properties.
b) The process settings (such as pressures and temperatures) concerning the machine and mould have to remain constant with regard to time and space.
c) Injection moulding machine characteristics.

An example of a commercially available injection moulding machine is shown in Figure 1.

Figure 1. Injection molding machine installed at Mechanical engineering faculty in Slavonski Brod

2. Computer simulations of injection molding process

The use of computers in manufacturing operations dates back to early work in the 1950s in which was used to control metal cutting machine tools. During the following couple decades, the rapid developments of CAD/CEA/CAM resulted in three-dimensional representations of objects. Some of achievements in injection moulding simulation process were commercialized and today well known as Moldflow, Moldex3D, ANSYS CFX, Solidworks plastics etc. Reliable CEA simulations tools could replace traditional trial-error approach and assist to select materials, product and mold design and molding condition set up. Moreover, some of the CEA software's could suggest optimal process condition to achieve acceptable quality parts.

3. Cavity fill and cooling simulations of injection molding process

In this part of the paper computer simulations of the filling and cooling process was described. Before computer simulation of injection moulding of the tensile test specimen, a number of mould cavities were determined as well as the type of mould runner system and the gate.

Based on maximum injection volume of injection molding machine mould and the planned number of products, it has been decided that the mould with one mould cavities shall be made with cold runner system. Figure 2 shows a moulded parts and a runner system (material output from the injection moulding process).

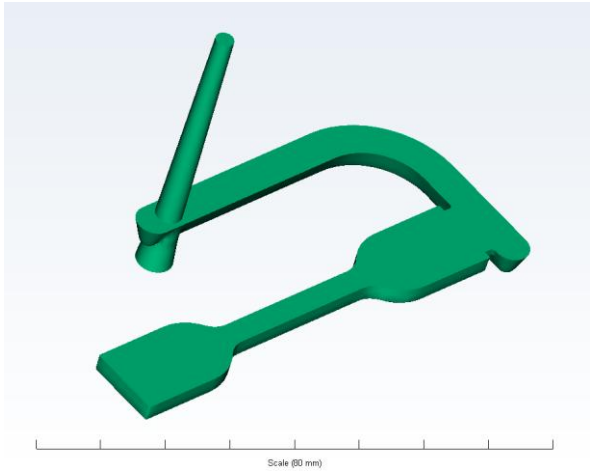

Figure 2. Tensile test specimen model for simulation

The Fill analysis predicts the thermoplastic polymer flow inside the mold in the filling phase. Some of the filling simulation results are: mould cavity filling time, (Fig. 3), necessary injection and drop pressures, polymer melt temperatures range, estimation of injection moulding time, probability of complete mould cavity filling etc.

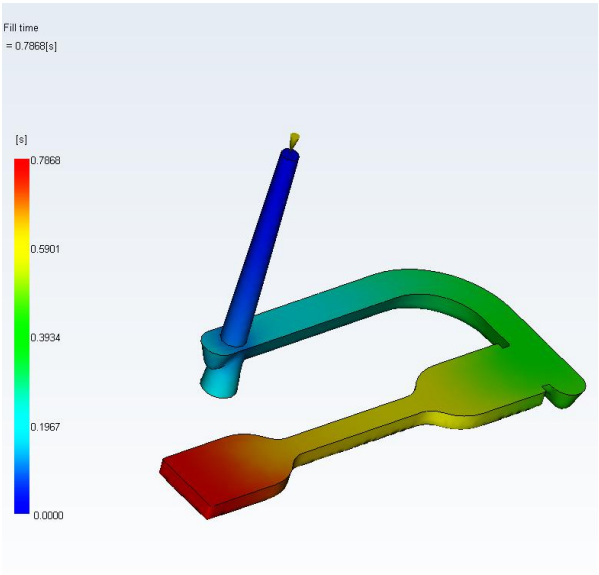

Figure 3. Simulation of cavity fill time

The injection pressure is the pressure that is applied to the plastic by the ram during the injection phase, causing the material to flow. Injection pressure can be measured approximately by a transducer located in the nozzle. The direct relationship between the injection pressure and the hydraulic pressure is called the machine intensification ratio. At the beginning of filling, the pressure is zero, or 1 bar in the absolute pressure scale, throughout the mold. The pressure at a specific location starts to increase only after the melt front reaches that location. The pressure continues to increase as the melt front moves past, due to the increasing flow length between this specific location and the melt front.

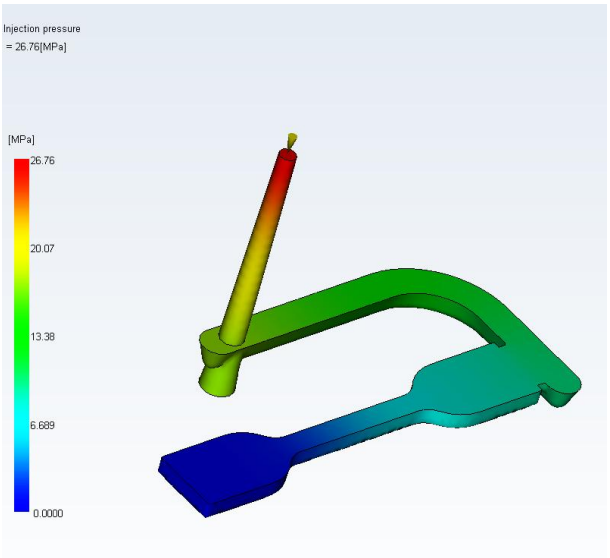

Figure 4. Simulation of injection pressure needed for mold cavity filling

The Time to reach ejection temperature result shows the amount of time required to reach the

ejection temperature, which is measured from the start of fill. Ideally, the part should freeze uniformly. Areas of the part that take longer to freeze may indicate thicker areas of the part or areas of shear heat during filling and/or packing.

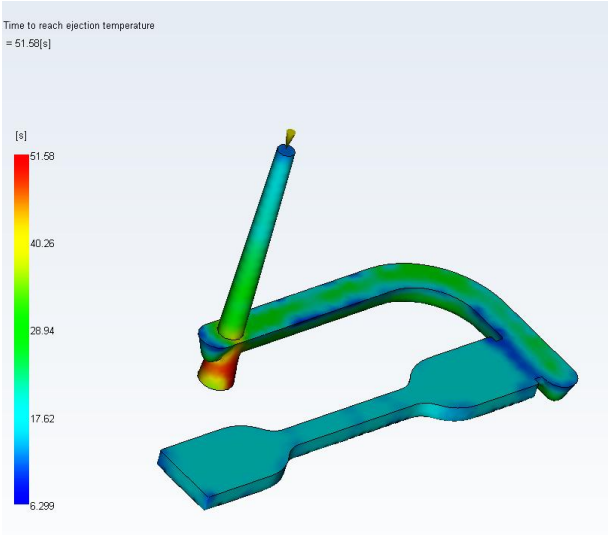

Figure 5. Simulation of ejection time

The Confidence of fill result displays the probability of plastic filling a region within the cavity under conventional injection molding conditions. The colors displayed in the Confidence of fill result indicate the following: green color – will definitely fill, red color – will be difficult to fill or will have quality problems.

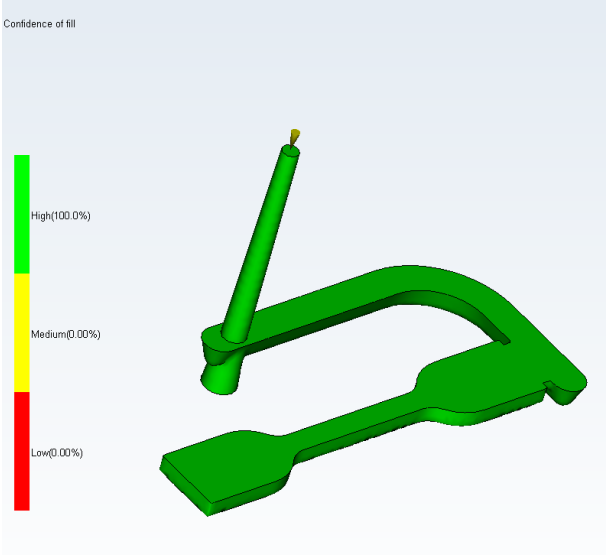

Figure 6. Confidence of fill simulation

4. Conclusion

Injection moulding process is one of the most important processes for the production of polymer parts. It is worth noting that 75 % of faults in the lifetime of injection moulded polymer parts are initiated in the process of developing and designing the parts. The paper briefly describes the simulation process from part technical checking to simulation of fill and cooling conditions. Polymeric material chosen for simulation was PE-HD (Borealis MG9641MB) and tensile test specimen according ISO 527 as injection molded part.

Based on the results of computer simulation, it was concluded that under determined molded part geometry and selected material (PE-HD), no difficulties during injection moulding are to be expected.

Further research will go in the direction of getting the appropriate relationship between simulation results and real injection molding process.

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