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- Mechanical Engineering Faculty in Slavonski Brod, Josip Juraj Strossmayer University of Osijek, Slavonski Brod, Croatia
- Kecskemét College, Faculty of Mechanical Engineering and Automation (GAMF), Kecskemét, Hungary
- Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Trnava, Slovakia

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CONTENT

PLENARY LECTURES

A NEW PRACTICE ORIENTED (DUAL TYPE) EDUCATION AT KECSKEMET COLLEGE - VEHICLE ENGINEERING COURSE

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Abstract
Hungary became a vehicle manufacturing country in the last few years. Due to the settling of big manufadcturers, the requirement for the human manpower is increasing. In this article a new type of higher education is presented. This type of education is well known in Germany, however it is relatively new in Hungary.

Keywords:
vehicle engineering, dual type education, higher education, GAMF

1. Introduction

Economical productivity of Hungary cannot be compared to the developed countries, however the structure of the Hungarian industry is competitive. Our productivity contains a relatively high ratio of the given value (Fig.1).

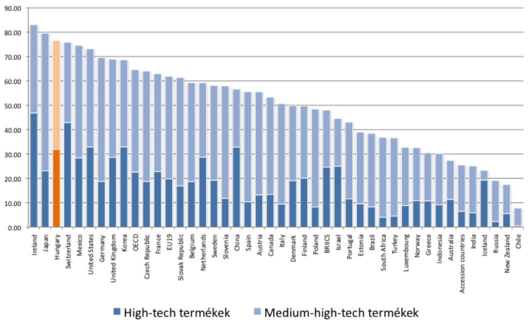

Figure 1. Hungary is the third in the value added productivity in the ranking list of the OECD countries. [OECD Science, Technology and Industry Scoreboard 2009 - OECD © 2009 - ISBN 9789264063716]

Unfortunately, this rank does not mean that research and development is also situated in Hungary, however some industry – especially vehicle manufacturing – has started some product development.

International practice shows that maintaining the high value added production can be carried out only by highly educated workforce. Hungary has some advantages i.e. relatively low work force expenses especially if it compared to Germany. (The approximate ratio is 1:3.) The other benefit is that there is no third party in the development, therefore the settled technology is in “safety”. (Compare it to the Asian countries.) However there is an increasing problem in Hungary namely the shortage of the educated workers and engineers (Fig.2).

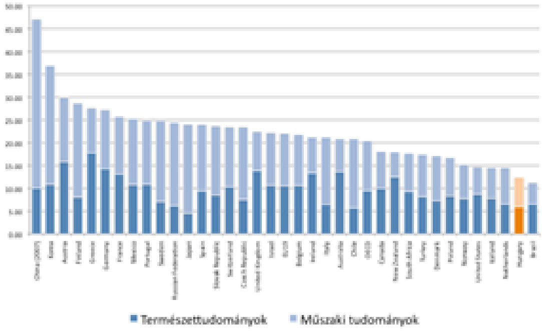

Figure 2. Diploms of natural sciences and engineers is lew in Hungary [Education at a Glance 2010: OECD Indicators. ISBN: 9789264055988 Publication: 7/9/2010]

Similar situation was in Germany in early 1960. Education was reorganized and a new type of education appeared the dual type education. The main idea of this education is to share the tasks and the expenses between the public and the industry.

It started with the vocational education, and in the nineties it was introduced in the higher education, too. From that time several other countries (Austria, Swiss, France, Denmark, etc.) have introduced the dual education.

In the universities and colleges there are several types of practical education (Fig. 3). In research universities there is only a six week practical at enterprises. This time is not sufficient to do any useful work. Students can see a factory inside, but they do not have enough time to do project. They usually start their diploma work.

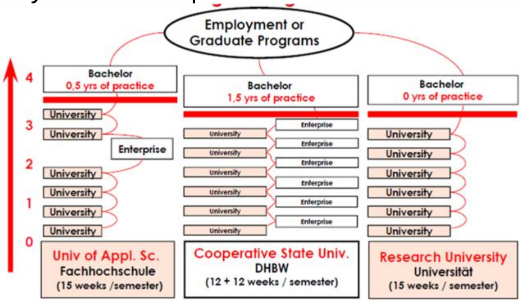

Figure 3. Types of educations

2. Analysing the situation

Industrial partners need useful engineers to maintain the technology and to develop new products. Doing discussions with the representatives of the manufacturers the main expectations were determined:

- More practice
- Problem solving capability
- Knowledge of working in team and working for the factory
- Strong theoretical basis and its application in practice
- Short education time (3-4 years)
- Theoretical foundation of the necessary skills and ability
- Industrial experts in the education

However not only the industrial partners expressed their expectations, but the society did, too. In the point of view of the society, there are three main topics:

- Cheaper education
- More flexible education
- Quality education

These expectations are obvious.
Furthermore, the institutions (university or college) have a few demands:

- No new accreditation
- Fit to the present time frame
- Thoroughfare between normal and dual type educations

The accreditation process is usually a time consuming one. It normally takes half a year, therefore if one wants a fast introduction it is better to fit a new system into an already accredited branched. In this case the time frame is given (15 weeks), and practically the thoroughfare is also solved.
The conclusion of the analysis is summarized in Figure 4. Theoretical education should be held at the institute (university or college) and the practical education is shared between the institute and an industrial partner. It is very important that the industrial practice is equivalent to the ones at institutes. In this case it is essential that the normal and the dual type education is interchangeable,

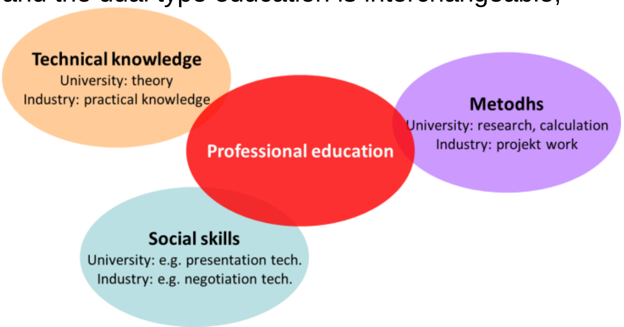

Figure 4. Components of the professional education

3. Structure of the education

The normal BSc a semester time frame consists of 15 week contact time (lectures and practices) and 6 weeks examination period. Rest of the year (approximately 10 weeks) is holyday for the students. In the dual type of education the holyday period is transferred to industrial practice. Naturally, the students have holyday (approximately 4 weeks/year), but it is organized by the company (Fig. 5).

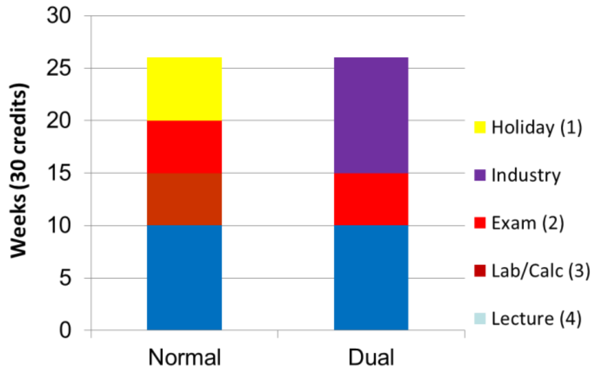

Figure 5. Comparison of the normal and the dual type BSc education

Normally, the lectures and practices are held in weekly schedule. However in this case, it creates a problem with the industrial partner participation. To solve the problem, the lectures and practices is separated. We created a so called lecture block (approximately 10 weeks) and practical block (approximately 5 weeks. The practical work in this case can be organized at the industrial partner. During this period, the students can make their exams, too. After the practices, the students start project work. It is very important, that the project should be connected to the theoretical part, and it should be connected to the infrastructure of the company.

4. Summary

A new type of educational model was developed and introduced at Kecskemet College Faculty of GAMF. The vehicle engineering BSc course was reorganized and industrial partners were involved in the education. This dual type education fits to the requirements of the industry, of the society and of the institute. Students taking part in this education have more practical education, and they get information on project work. Furthermore they become familiar to the given industrial partner, therefore after graduation they can start their work at factory immediately.

IRRIGATION – WISH OR NECESSITY

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Abstract
Until 2003 there were 9 275 ha under irrigation, which represents 0.86% of arable lands in Croatia. Irrigation systems were unorganized and conducted without plans with undefined rights and obligations of the participants. Surfaces under irrigation were small and the consequences of drought were measured in millions. Croatian government in 2005 has accepted the National Project of Irrigation and Land and Water Management in the Republic of Croatia. Main goal of the project is to increase surfaces under irrigation to 65 000 ha until 2020, which represents 6% of arable lands in Croatia. It would take planed approach to achieve this plan, and is possible thru building of infrastructure and with enlargement of production surfaces of the farmers. Until 2012 irrigated surfaces were increased up to 12 000 which is less then planed.

Keywords: irrigation, NAPNAV, drought

1. Introduction

Number of people included in agricultural production as main economic activity is much larger than other productions. In total world water consumption agricultural production participates with the highest 70% compare to industry (25%) and households (8%).
Main task of agricultural production is to secure enough food and raw materials for humanity which indicates to importance of correct use and application of all factors in agricultural production. Main factors in plant production are water, sunlight, temperature and soil, and in this paper water or water deficit will be presented.
Main source of available water in soil are precipitations – rain. Annual distribution of precipitation mostly does not correspond to the needs of the plants. For the analysis of weather conditions it is better to analyze amount of precipitation and temperatures in vegetation season which is used in this paper. Insufficient amount of precipitation and increase of air temperatures leads to higher water demand in plant.
Irrigation is agricultural measure which in artificial way gives water to the plant. From totally 1.5 million ha of planted surfaces in world, 250 million are irrigated which represents 18% of arable lands in world. Almost 40% of food has been produced on irrigated surfaces.

2. Irrigation in Republic of Croatia

In Europe 13% of arable lands are irrigated. In our surroundings – Italy, Greek, Bulgaria, Romania are irrigating 20% to 30% and Hungary 5% of arable lands [3]. Unfortunately, Croatia is at the bottom of the list regarding the surfaces under irrigation. Until 2003 [1] there were 9 275 ha under irrigation (1 077 403 ha), which represents 0.86% of arable lands in Croatia and 0.30% of agricultural lands.
General condition regarding the irrigation in Croatia could be evaluated as poor. There are few reason for this condition; irrigation system are unorganized, rights and obligations of participants in system were undefined, plans for progress were undefined, problems with the land owners, destruction of large agricultural producers, importance of irrigation; the end user or farmer was not included in management of irrigation and small production surfaces (Table 1).

Table 1. Average number and size of production surfaces in Croatia

	ha/household	Number o surfaces/ household	Average surfaces (ha)
Croatia	1.9	4.3	0.45

Small production surfaces are large financial and organization problem for economically organization of irrigation system.
In Republic of Croatia there are 3 187 494 ha of agricultural land with structure as follows: 2 043 767 ha in private properties which represents 46%, and 1 143 727 ha of state properties which represents 36% [2]. Large portion of private owners indicates to better need for financial support and organization of system for end users. Are conditions in Croatia much more favorable for irrigation than the one who are used?
Natural resources that are suitable for irrigation in Croatia are suitable soils and quality available water for irrigation. Amount of natural water resources (rivers, accumulations, wells, lakes) and the quality of water potential in Croatia could satisfy bigger consumption for irrigation than the

one who exist [3]. According to water potential, Croatia occupies 42nd place in World.
It is necessarily to construct artificially resource like canals and accumulations for irrigation water were there are no natural resources and the soil are suitable.

3. Necessity for irrigation

In average climate conditions in Croatia, yield reduction dry farming area is 10% to 60%, and up to 90% in dry vegetation seasons, depending on soil, culture and region [1].

Table 1. Analysis of dry, average, extreme wet years by Hydrothermal coefficient by Seljaninov

Hydrothermal coefficient by Seljaninov		
Years	Osijek	Sl. Brod
1973	Average years	Dry years
1974	Extreme wet years	Extreme wet years
1975	Average years	Extreme wet years
1976	Average years	Extreme wet years
1977	Dry years	Extreme wet years
1978	Average years	Average years
1979	Dry years	Average years
1980	Average years	Extreme wet years
1981	Average years	Extreme wet years
1982	Dry years	Average years
1983	Dry years	Average years
1984	Average years	Extreme wet years
1985	Dry years	Average years
1986	Dry years	Average years
1987	Average years	Average years
1988	Dry years	Dry years
1989	Average years	Extreme wet years
1990	Average years	Average years
1991	Average years	Extreme wet years
1992	Dry years	Average years
1993	Dry years	Average years
1994	Average years	Extreme wet years
1995	Extreme wet years	Average years
1996	Extreme wet years	Extreme wet years
1997	Average years	Average years
1998	Average years	Extreme wet years
1999	Extreme wet years	Extreme wet years
2000	Extreme dry years	Dry years
2001	Extreme wet years	Extreme wet years
2002	Extreme wet years	Extreme wet years
2003	Extreme dry years	Extreme dry years
2004	Extreme wet years	Average years
2005	Extreme wet years	Extreme wet years
2006	Average years	Average years
2007	Extreme dry years	Average years
2008	Average years	Average years
2009	Extreme dry years	Extreme dry years
2010	Extreme wet years	Extreme wet years
2011	Extreme dry years	Extreme dry years

	Extreme wet years
	Average years
	Dry years
	Extreme dry years

There are many advantages in irrigation use: high and stable yields in years with average weather conditions but plant production in dry years as well. Negative outcome of water deficit is reduced and man can achieve higher yield per area unit. In favorable conditions in soil the effectives of mineral fertilizers is better.
If we take in account all of the advantages of irrigation it could be said that every farmer and producer wish to irrigate. But, beside the desire it is necessarily to take in account all of the scientific criteria in order to apply irrigation in plant production.
A main criterion who determines is it necessarily to irrigate or not, is plants demand for water and amount of available water.
Analysis of weather and climate conditions in vegetation season is taken by Hydrothermal Coefficient by Seljaninov (HTC). Air temperatures and rainfall have been analyzed for vegetation season in Osijek and Slavonski Brod area. Period of research is 39 years, from 1973 to 2011, (Table 2). Result of analysis had shown 14 dry years in Osijek area and 6 dry years in Slavonski Brod area. From 1994 to 2011 (last 18 years) every 6th year was dry in Osijek area and every 3th year in Slavonski Brod area. In same period every 8th year was extremely wet in Osijek and Slavonski Brod area. Dry and wet years and vegetation seasons are implying to weather oscillation.
Advice from professional's agronomist is to make an analysis of weather conditions for period from 20 to 30 years.
According to Šoštarić [2] in decade from 1882 to 1993 every 6th to 10 year was dry.

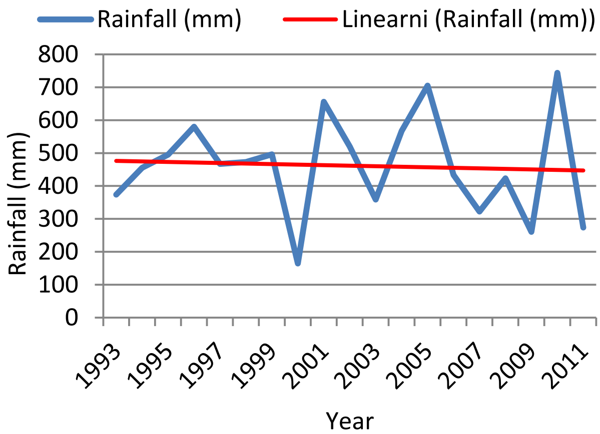

Figure 1. Rainfall (mm) and trend in temperature decreasing in Osijek area 1993-2011

Amount of rainfall and trend in rainfall reduction in Osijek area for period from 1993 to 2011 is presented in Figure 1.
Average air temperatures (^{o}C) in period from 1993 to 2011 for Osijek area and trend in air temperatures increasing is presented in Figure 2.

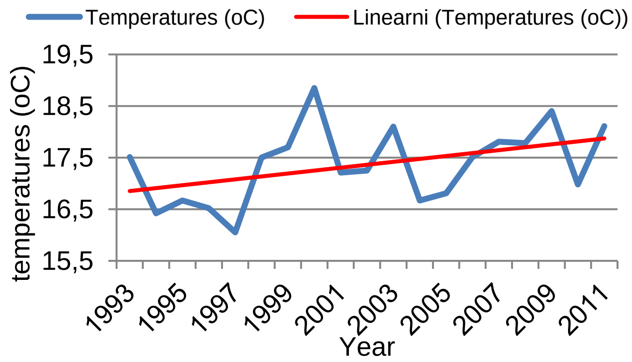

Figure 2. Average air temperatures (^{o}C) and trend in temperature inceasing in Osijek 1993-2011

Amount of rainfall and trend in rainfall reduction in Slavonski Brod area for period from 1993 to 2011 is presented in Figure 3.

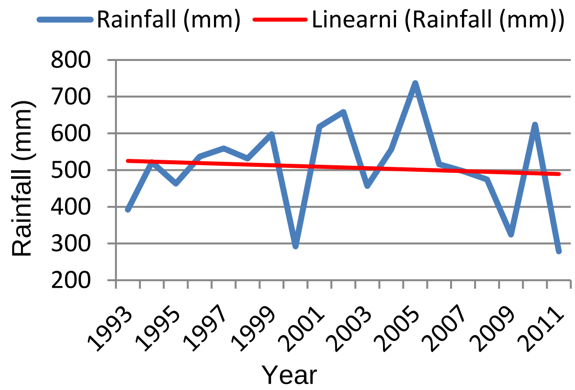

Figure 3. Rainfall (mm) and trend in rainfall decreasing in Slavonski Brod area 1993-2011

Average air temperatures (^{o}C) in period from 1993 to 2011 for Slavonski Brod area and trend in air temperatures increasing is presented in Figure 4.
This transition of dry and wet years and vegetation seasons indicates to importance of management agricultural lands from excessive water (drainage) and dealing with water deficit (irrigation).

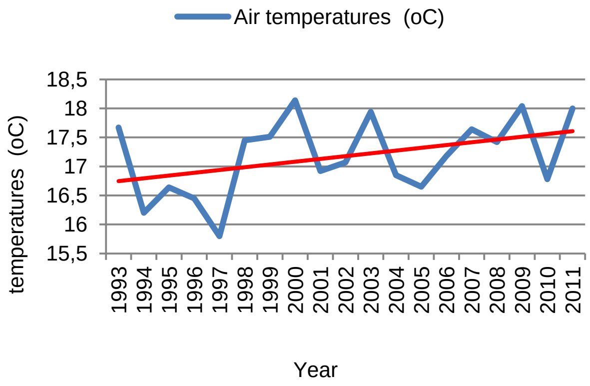

Figure 4. Average air temperatures (^{o}C) and trend in temperature increasing in Slavonski Brod 1993-2011

4. National Project of Irrigation and Land and Water Management in the Republic of Croatia (NAPNAV)

Only two dry years (2000 and 2003) have resulted with damage from drought up to 3.4 billion of Croatian Kuna [3]. That was the reason for the experts who are dealing with irrigation and agricultural amelioration to draw attention to this problem and offer their help to the government in form of long-term plan for irrigation in Republic of Croatia.
Government of Croatian Republic has accepted National Project of Irrigation and Land and Water Management in the Republic of Croatia (NAPNAV) in year 2005. Plan came as result of work 42 experts and 2 international consultants.
Main goal of National Project of Irrigation and Land and Water Management in the Republic of Croatia (NAPNAV) was to make conditions for better usage and exploitation of agricultural lands and to increase surfaces under irrigation.
Main task of the National Project of Irrigation and Land and Water Management in the Republic of Croatia (NAPNAV) to increase surfaces under irrigation from 9 264 ha from 2003 (0.86% of arable lands) to 65 000 ha (6% of arable lands) until the end of year 2020.
Main goal of National Project of Irrigation and Land and Water Management in the Republic of Croatia (NAPNAV) is:
- to analyze and define the potentials for irrigation;
- to define rights and obligations of all participants in system;
- to be able to see expected results from irrigation from economic and social view;
- to ensure infrastructure for irrigation;
- to make adjustment in law applying (water rights, land rights).

In realization of National Project of Irrigation and Land and Water Management in the Republic of Croatia (NAPNAV) very important role have

Counties. Plans for irrigation as main document are made at County level. Main criteria's for project are:
- soils suitable for irrigation;
- amount of water;
- prepared project documentation;
- system effectiveness.

To be able to approach to irrigation some of the factors like drainage of excessive water from the surface must be done. Excessive amount of water refers to the water from wet time of year – late spring and early autumn, whit the open canals.
The plan is to clean and maintain 22 000 km of canals.
Most of the drainage system has been constructed 30 years ago with financial support of Yugoslavian government. Canals were mainly located at surfaces of former corporations.
Financing and maintaining of canals and drainage infrastructure was poor so most of the canals are damaged.
It is necessarily to make infrastructure to brought water to end users. Implementation of large project such as this demands large quantities of financial and expert support. Realization of project (NAPNAV) takes 3 billion of Croatian Kuna from state budget and 1.4 billion from end users.
Financial support for project comes from:
- state budget Republic of Croatia;
- international institutions;
- regional and local authorities;
- end users (farmers and producers).

When Croatia becomes one of the members of European Union it would be possible to take a financial support from EU funds.
At the beginning there are some problems of financial and bureaucratic nature. Lott of time could be spend to gain all necessarily documents and license. Unresolved owner issues could be great problem for end users. Also, the economical crisis had negative influence to project financing.
There is some indirect benefit of the NAPNAV:
- development of rural area;
- increasing of farmers and producers income;
- more workplaces.

5. Conclusions

Although there are several naturals factors (fertile soils, clean and fresh water for irrigation) suitable for irrigation, only 0.86% of arable lands have been irrigated in Croatia. It is planned to increase surfaces under irrigation by implement National Project of Irrigation and Land and Water Management in the Republic of Croatia (NAPNAV). Analysis of weather condition in Osijek and Slavonski Brod area (1973 to 2011) shown increase in appearing of dry and extremely dry year. During dry and extremely dry vegetation season plant has higher demands for water and irrigation becomes justify agricultural measure. It was plan to irrigate 45 000 ha up to 2012 but there is only 12 000 ha which is significantly lower. Irrigation with all of his benefits is often forgotten with first drops of rain.

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ADVANCED EVALUATION MODEL OF EXPECTED ENERGY NOT SUPPLIED IN DISTRIBUTION POWER NETWORK

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Abstract
Expected energy not supplied (EENS), caused by faults and maintenance activities, is overestimated with classical approach. There are important direct financial losses (power system's company, industry sector, financial institutions) and indirect losses (education, culture, life standard) due to non voltage periods. System controlling and data acquisition (SCADA), integrated in modern distribution power system, improves possibilities in data analyzing and prediction of the EENS in more exact and efficient way. Power demand and energy grow up immediately after non voltage period, for several analyzed cases (less than 1 hour) are twice greater then usually (power memory effect), so the EENS during the non voltage periods are even more then 50% less.

Keywords:
Distribution Power System Demand, Non-Voltage Period, Modeling, Expected Energy Not Supplied

1. Introduction

Electric energy supply is one of the most important civilization's bases for normal nowadays human life. There are a number of activities that could not be achieved without the assistance of electricity. There are many examples in the industry, agriculture, farming, education, catering etc. Although it is a fact that power systems work very reliably, power system fault happens from time to time in some rare situations. There are many aspects about the expected energy not supplied (EENS) price, about estimation of the economies losses and the social economic benefit losses in the different kinds of human activity, education and life or about similar estimation in suppliers money losses due to not charged EENS, [1] and [2]. Here are technical analyzes of some real power system faults, real demands and real deliveries. The quantity evaluation of expected energy not supplied is given here. Fault period without voltage of the day is compared with the same time period of the next or previous day. The values of expected energy not supplied until now have been overestimated due to demand power memory effect of installed devices on power line. Real values of EENS could be gotten by integrating function of power (or electric current) depending on time for each day (two consecutive days).

Power system supply has to be of high reliability level, but there are failures of the components causing non-voltage periods. These periods are registered by power Supply Company to decrease non-voltage periods of the same type of the component by components replacements, estimation of component's life cycle or maintenance activities or to reduce failure cause. Simultaneously, expected energy not supplied has to be evaluated to have right information about money losses and to manage failures according to their impact on power Supply Company.

2. EENS in distribution power network (conventional and advanced model)

Komen [3] and Šljivac [4], [5] estimate total money losses of EENS on industry, agriculture, service sector and households in Croatia, comparing results with other countries. Direct money losses evaluation due to energy not supplied is important part in power supply company management and development strategy. HEP-DSO has procedure for EENS calculation for different cases, depending on accessibility of load history data and duration of non-voltage period. The fault duration is mostly exact known variable (if there is SCADA system) or it is estimated by the consumer's notification about the failure, [6]. For example, EENS is usually determined as a multiplication of average months (seasons, years) power load (or determined percent of installed power load) and time period:

$$EENS_{con} = L_A \cdot D_{nv} \qquad (1)$$

$EENS_{con}$ [kWh] – expected energy not supplied,
L_A [kW] – average power load
D_{nv} [h] – time duration of non-voltage period

In cases with load data on-line measured by SCADA system, average month's power load in (1) is substituted by momentary power load in the failure moment. Typical failure of the power line is presented in Figure 1, by load curve as function of time. In general, EENS evaluation is better if the failure lasts very short, due to daily changes of the power load on analyzed power line [7]. It is much better for EENS evaluation to use load history data to estimate daily load curve as better as it is possible, especially comparing typical daily curves between two consecutive days. It is very important to take in account all climate influences, such as load as a function of average daily temperature.

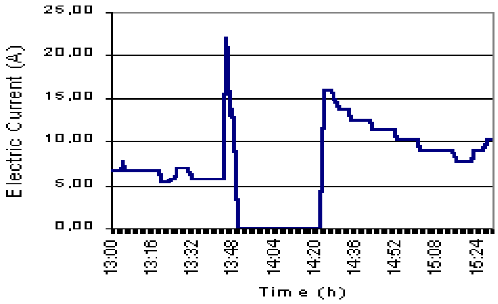

Figure 1. Electric current as a function of time on fault day

New advanced model of EENS evaluation developed here is based on a number of real power system faults, real load demands and real load delivers. Several of these faults, given by load history data from PROZA R/F SCADA of distribution power network of Slavonski Brod and Nova Gradiška, are described here in the paper. Missing load curve of the fault day is substituted by the load curve of the same day period of the next or previous day. Attention has to be paid to load curve shape's differences between workdays and weekends. If the analyzed fault day is a workday, comparison has to be done with the first workday before or after faults day, and with intention to select the day with approximately similar load and temperature conditions in the moment of the failure. The similar average daily temperatures of two consecutive days are important viewpoint for taking in account the two near days. Load power curve of consecutive days does not differ in a considerable value and shape too. There are similarities in shape of daily power load of consecutive days, as it is described in figure 2. Measurement was carried out with calculating average values each 2 hours on power transformer 630 kVA installed in transformer substation 10/0,4 kV. To make as better as possible EENS evaluation, it has to be select daily power load curve that best fits to fault day curve before beginning of the fault (before non-voltage period) and after stabilization period. The evaluations of EENS until now have been overestimated, because initial extraordinary load demand was not taking in account. It is caused by load need of installed devices which are deferred due to non-voltage period. There are two different types of electric devices: devices with momentary urgent need for load (indoor lighting, motors applied in industry and crafts), and devices with deferrable need for load (automatic regulation of temperature in refrigerators and boilers and automatic regulation of level in pump's systems, irrigation systems, water supply systems, drainage systems etc).

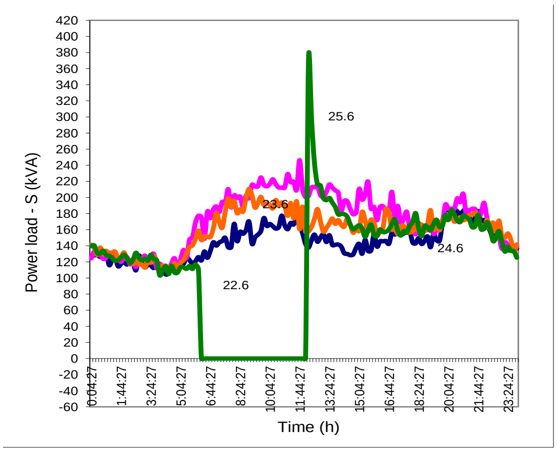

Figure 2. Daily power load for several consecutive days

Herein applied new model for real evaluation of EENS is defined as integration of load-time function, starting on a moment of failure occurs (similar like in conventional approach) and end with the last time point of the stabilization period of the load for the two consecutive days. Stabilization period is defined as intersection of the power loads after the non-voltage period of failure day and next day. Memory load effect during stabilization period presented in figures 3 and 4, explains the appearance of overload during some time (stabilization period), sometimes with 100-150 percentage more load magnitude then in usual load shape of the next day. Conventional approach of EENS is marked by E (area under load curve during non-voltage period).

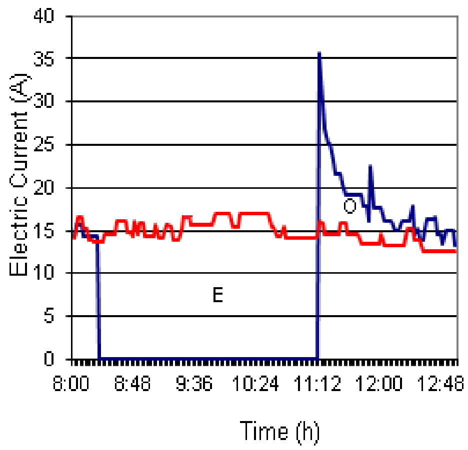

Figure 3. Electric current function I(t) on fault day

and next day

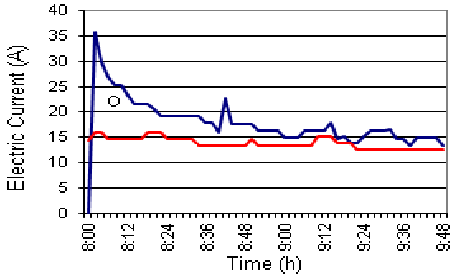

Figure 4. Electric current function I(t) on fault day and next day

The first step in calculating expected energy not supplied by new advanced model ($EENS_{new}$) is quantity evaluation of EENS by conventional model ($EENS_{con}$). $EENS_{con}$ is proportional to surface of area marked E in Figure 3 – area under load-time function and it is calculated as:

$$EENS_{con} = \int_{0}^{D_{nv,s}} C \cdot I_{nv}(t) \cdot dt \tag{2}$$

$$C = \frac{\sqrt{3}}{3600} \cdot U_l \cdot \cos\varphi \tag{3}$$

Where:

$I_{nv}(t)$ [A] – current-time function of the next day during period of non-voltage period of fault day
t [s] – time as independent variable
U_l [V] – rated voltage level
$D_{nv,s}$ [s] – time duration of non-voltage period
φ – angle between phasors of voltage and current

SCADA is tuned to get new measurement of electric voltage and current each k seconds (1 s – 5 s), what is the base point for numerical method application of integration problem:

$$EENS_{con} = C \sum_{i=1}^{i=\frac{D_{nv,s}}{k}} I_{nv,i} \cdot k \tag{4}$$

$I_{nv,i}$ [A] – average current (next day) of ith measured time interval during non-voltage period
k [s] – time interval of measurement pattern

Here, measurement pattern is defined by SCADA time pattern. It has to be set to get average, minimum and maximum values of load (electric current) according to duration of non voltage period. Better to say, k is constant time width of rectangular with height of average current of ith measured interval. To get accurate data of EENS that are applied for numerical integration method, the best solution is to time pattern set on as short as possible duration.

Surface, marked by "O" in Figure 3 and Figure 4, between two load-time functions of fault day and next day represents electric energy what is particularly compensation of demand from previous period without voltage. New developed model is based on stabilization period with significant increased load "O" (area between load curves of two consecutive days). Stabilization period (D_s) is a time period starting by the end of non-voltage period (repair or substitution of faulted component) and ending by intersection of two load characteristics. It means, that conventional model of EENS calculation get overestimated EENS ($EENS_o$).

$$EENS_o = \int_{0}^{D_{s,s}} C \cdot \left[I_{s,fd}(t) - I_{s,nd}(t) \right] \cdot dt \tag{5}$$

$EENS_o$ [kWh] – overestimated part of EENS
D_s [s] – stabilization period
$I_{s,fd}(t)$[A] - current-time function of fault day during stabilization period
$I_{s,nd}(t)$[A] - current-time function of next day during stabilization period

$$EENS_o = C \sum_{i=1}^{i=\frac{D_s}{k}} (I_{s,fd,i} - I_{s,nd,i}) \cdot k \tag{6}$$

$I_{s,fd,i}$ [A] – average current (fault day) of ith measured time interval in stabilization period
$I_{s,nd,i}$ [A] – average current (next day) of ith measured time interval in stabilization period

So, $EENS_{new}$ can be defined as:

$$EENS_{new} = EENS_{con} - EENS_o \tag{7}$$

3. Analyze of several real faults in distribution power system

Stabilization period duration and percentage of overload comparing to usual load curve mainly depend on duration of non-voltage period. Of course, there are several additional non-dominant influences, like power line 10 kV character (installed devices, configuration) and outdoor temperature and customer's habits (life standard). Characteristic analyzed distribution power system's faults are described in the Table 1 and Table 2 in detail. According to EN 50160 Voltage Disturbances important reliability indices of power supply aspects are interruption duration, interruption frequency and number of consumers without power supply during interruption. Intention is to reduce all three parameters during power faults period. After fault is located and repaired, power lines are energized. Initial electric current occurs immediately after end of non-voltage period, and it depends on non-voltage period duration and character of power line (number and type of consumers). Initial electric current ratio is defined as ratio of initial electric current value of fault day and value of electric current of regular (next) day in moment immediately after end of non-voltage period (Io/In). Table 1 shows initial electric current ratio, duration of stabilization period and duration of non-voltage period for several analyzed faults. Table 2 describes EENScon and EENSnew for the same faults as described in Table 1. It is obvious that there are mathematical functions between all these parameters depending on duration of non-voltage period.

Table 1. Initial electric current ratio and stabilization period for several analyzed faults

Faults on power lines	D_{nv} [s]	I_o / I_n	D_s [s]
Rogolji	2040	2,061893	2280
D. Bogicevci	10200	2,221768	6000
Cesarceva	21000	2,805864	8400
Slobodnica	61200	not measured	11700

Table 2. Conventional model of EENS and new advanced model of EENS evaluation for several analyzed faults

Faults on power lines	D_{nv} [s]	$EENS_{con}$ [kWh]	$EENS_{new}$ [kWh]
Rogolji	2040	83,304	34,534
D. Bogicevci	10200	716,709	587,870
Cesarceva	21000	843,847	679,678
Slobodnica	61200	1090,420	966,464

4. Conclusion

Increasing number of end-users connected on distribution power network and intensively growing up of population density cause the increasing growth of electricity consumption. So, real quantitative model for evaluation of EENS becomes more and more important. Not so long ago in the past, evaluation of EENS has been calculated by subjective qualitative estimation on the base of available annual or season measurements. Modeling of EENS evaluation is easier today because load history data (SCADA) and data from temporary mounted load measurement registers are available. Depending on programmed parameters of these measurement devices, measurement sampling is adjusted on intervals between 1 s and 60 s, what is adequately precise for evaluation of EENS. In a case when duration of non-voltage period is less than 1 hour, real EENS given by new approach is about 40-50% than EENS given by conventional approach. In a case of longer duration of non-voltage period overestimated EENS is only 20%. In most of the faults cases energy consumption in stabilization period is at least 50% more than energy consumption of the next day in the same time interval. The minimum overestimated EENS in stabilization period in conventional approach is at least 30% more than energy consumption of the next day in the same time interval. Duration of stabilization period changes from 111% of duration of non-voltage period for short-term faults to 0,19% of duration of non-voltage period for very long-term faults (ten or more hours). Herein proposed model for EENS evaluation has to be base point for further investigation on EENS on different distribution power lines, classified by installed load, peak load, character of load etc. It has to get several power lines with the same or similar characteristic consume (daily load curve) during longer analyzed period and analyzing several faults per one power line.

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TECHNIC SECTION

PRODUCTION AND TESTING OF PRODUCTS REALIZED BY FUSED DEPOSITION MODELLING TECHNOLOGY

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Abstract
Rapid Prototyping (RP) presents the automatic production of physical parts using by additive manufacturing technology. The start techniques for Rapid Prototyping became available in the late 1980s and were used to produce models and prototype parts. Today they are used for a much wider range of applications and are even used to manufacture production-quality parts in relatively small numbers. Rapid Prototyping is widely used in the automotive, aerospace, medical, and consumer products industries. In paper is presented process of design product development, product production and testing of products produced by Fused Deposition Modelling rapid prototyping technology.

Keywords:
Rapid Prototyping, Fused Deposition Modelling, product testing

1. Introduction

Rapid Prototyping (RP) is presented as a group of techniques used to quickly creation a scale model of a part or product using three-dimensional (3D) Computer Aided Design (CAD) data. What is commonly considered to be the first RP technique, Stereolithography was developed by 3D Systems of Valencia, CA, USA. The company was founded in 1986, and since then, a number of different RP techniques have become available.
Rapid Prototyping is also been referred as solid free-form manufacturing, computer automated manufacturing and layered manufacturing technology. RP has obvious use as an aid for visualization. In addition, RP models can be used for testing such as when an airfoil shape is put into a wind tunnel. RP models can be used to create male models for tooling such as silicone rubber moulds and investment casts. In some cases the RP part can be the final part but typically the RP material is not strong or accurate enough. When the RP material is suitable, highly convoluted shapes can be produced.
There are a multitude of experimental RP methods either in development or used by small groups of individuals. This paper will focused on RP techniques that are currently commercially available, including Stereolithography (SLA), Laminated Object Manufacturing (LOM), Selective Laser Melting (SLM) and Fused Deposition Modelling (FDM) techniques.

2. Presentation of main RP methods

Patented in 1986, Stereolithography started the rapid prototyping revolution. The technique builds 3D models from liquid photosensitive polymers that solidify when exposed to ultraviolet light. The model is built upon a platform situated just below the surface in a vat of liquid epoxy or acrylate resin. A low-power highly focused UV laser traces out the first layer, solidifying the model's cross section while leaving excess areas liquid [1].
Next, an elevator incrementally lowers the platform into the liquid polymer. A sweeper re-coats the solidified layer with liquid, and the laser traces the second layer atop the first. This process is repeated until the prototype is complete. Afterwards, the solid part is removed from the vat and rinsed clean of excess liquid. Supports are broken off and the model is then placed in an ultraviolet oven for complete curing. SLA machines have been made since 1988 by 3D Systems of Valencia, CA. To this day, 3D Systems is the industry leader, selling more RP machines than any other company. Because it was the first technique, SLA is regarded as a benchmark by which other technologies are judged.
The Laminated Object Manufacturing (LOM) technique is used to produce low cost polymeric products (from polyvinyl chloride) that have to meet certain mechanical properties, especially if they are used to perform functional tests. The workers of Faculty of Mechanical Engineering and Naval Architecture of University of Zagreb (Croatia) realised testing the influence of the position of products in the machine working area on the mechanical properties of the product [2].
The test specimens made by LOM procedure was made of PVC film. The test bodies in LOM procedure was made on the machine SD 300 Pro, produced by Solido. SD 300 Pro is a machine which can produce transparent prototypes of PVC film, has small dimensions, and is practical for use in offices. Tests were carried out on specimens made using various orientations in the working area (Fig. 1):
- Lxy - test specimen laid in xy plane with height in z direction 4 mm,
- Pxy - test specimen raised in xy plane with height in z direction 10 mm,
- Pz - test specimen raised in z-axis with height 75 mm and 80 mm depending on whether the specimen is for tension or bending tests.

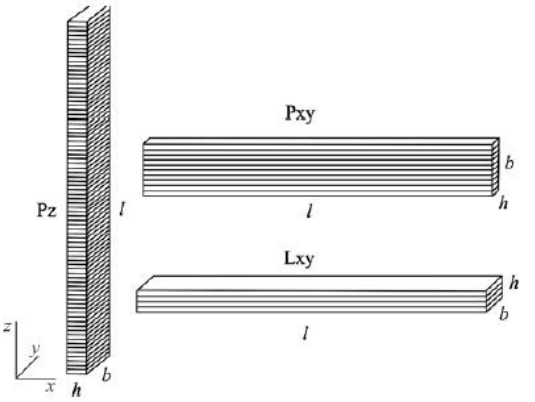

Figure 1. Orientation of layers in test specimen produced by LOM [2]

LOM procedure provides low surface roughness parameters in all three orientations. However, the lowest are in Lxy orientation which is only logical since the final layer is pure PVC film, independent of the construction (lamination) method. In test specimens Pxy and Pz, Ra is 95 times greater (Ra = 3 μm) than in Lxy orientation. The specimens of Lxy orientation have the highest strain, even up to an average of ε_p = 207 %, whereas the test specimens of Pz orientation have only ε_p = 24 %, which is 8.5 times lower value. However, it is interesting to note that the highest strength is not the feature of the test specimens of Lxy orientation, but the test specimens of Pxy orientation. Orientation affects also the fracture surface and in test specimens Pxy the surface is toothed, i.e. delamination of layers has occurred, whereas in Lxy and Pz the surface is flat. Such fracture in Pxy orientation occurs because the stresses are applied along each layer, and in Pz orientation the fracture occurs perpendicularly to the applied test force, and this is at the same time the layer lamination. The tests carried out at LOM test specimen lead to the conclusion that Pxy orientation features optimal properties. Possibly, in case of minimal roughness requirement and higher yield stress, Lxy orientation should be selected. The price and the manufacturing speed also depend on the orientation and chamber filling, so that the orientations in z-axis direction should be avoided as much as possible [2].

Selective Laser Melting (SLM) is the digitally driven process if direct from sliced 3D CAD data in layer thicknesses ranging from 20 to 100 μm products are realized. The process then builds the part by distributing an even layer of metallic powder using a recoater, then fusing each layer in turn under a tightly controlled inert atmosphere. Once complete, the part is removed from the powder bed and undergoes heat treatment and finishing. For the SML components were realized on the Department of Manufacturing Engineering of TU of Cluj-Napoca (Romania) tests with application of different SML machine parameters [3].

SLM is a complex thermo-physical process which depends on a lot of: material, laser, scan and environmental parameters. For two selected materials, a parameter study has been performed to optimize the process regarding part density, since porosity has a harmful effect on the mechanical properties of the part. Four main process parameters were selected for experiment: laser power, layer thickness, scan speed and hatching space. These factors determine the energy supplied by the laser beam to a volumetric unit of powder material, defined as energy density, an experimental quantity which has large influence on part density. After choosing the types of supports used for parts to be processed the next step is to see what material file is assigned for the future manufacturing component. Were two types of material used for manufacturing in the test, one is Ti6A17Nb and the other is stainless steel 316L. For the first material the optimal laser power could range from 50 to 200 W and the optimal power for stainless steel 316L is above 160 W. On the Fig. 2 are presented stainless steel samples with used laser power 120 W and 160 W.

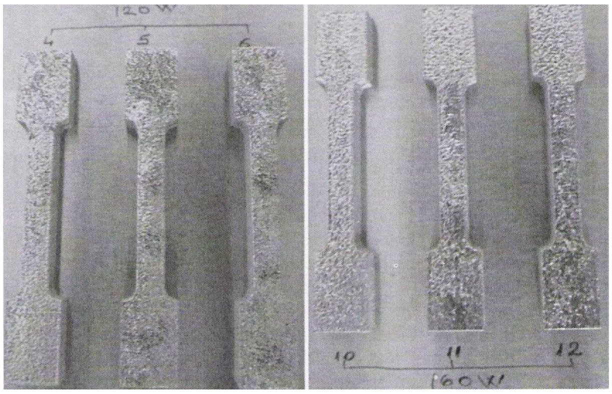

Figure 2. Stainless steel samples with used laser power 120 W, 160 W and 200 W [3]

If the power applied on the powder bed is less than 100 W the components are not so strongly melted. The best power chosen to be applied to the next components, samples or final components is 160 W, the best parameters between the good melting, process stability and final components with good results. One of the machine parameters who can be changed is the speed of scanning witch has the following calculating relationship applied on selective laser melting machine SLM 250 Realizer. The scanning speed was tested on samples to see if the standard scan speed of 400 mm/s is the best speed to melt the stainless steel powder or could be another one. To see that, different scanning speeds were attributed to the samples. The samples with higher scanning were not fully melted. The big value of scanning speed parameters is not optimal one because the powder layer is not strongly and fully melted.

In the samples with a low scanning parameter value the powder is extremely melted and these samples were very hard to detach from supports and also the supports from work table. After the process stability was tested the next step is to see the roughness results of the best samples manufactured with these parameters [3].
Stratasys Fused Deposition Modelling (FDM) is a typical RP process that can fabricate prototypes from ABS plastic. Researchers of Gyeongsang National University Jinju (Korea) and University of California, Berkeley (USA) realized selected tests the properties of parts fabricated by the FDM [4].
Using a Design of Experiment (DOE) approach, the process parameters of FDM, such as raster orientation, air gap, bead width, colour, and model temperature were examined. The FDM machine possesses a second nozzle that extrudes support material and builds support for any structure that has an overhang angle of less than 45° from horizontal as a default. If the angle is less than 45°, more than one-half of one bead is overhanging the contour below it, and therefore is likely to fall. Experiments were performed in which the effect of several process parameters on the mechanical behaviour of FDM parts was examined.
Fig. 3 shows magnified views of the fractured surfaces of the specimens. The Axial ($[0°]_{12}$) specimens showed tensile failure of individual fibers resulting in the highest tensile strength among the FDM specimens. This strength was lower than that of the injection moulded ABS partially because the gaps between fibers reduced the effective cross sectional area. The transverse ($[90°]_{12}$) specimens resulted in the lowest tensile strength because the tensile loads were taken only by the bonding between fibers, and not the fibers themselves. The cross specimen ($[0°/90°]_6$) consisted of a layer of fibers oriented in the 0° direction, followed by a layer in the 90° direction. The resulting failure load for this pattern, as might be expected, fell between the $[0°]_{12}$ and $[90°]_{12}$ specimens. The Criss-cross ($[45°/-45°]_6$) specimen showed shear failure along the 45° line in the macroscopic view but the microscopic view revealed the repeated failures of individual fibers by shearing and tension [4].

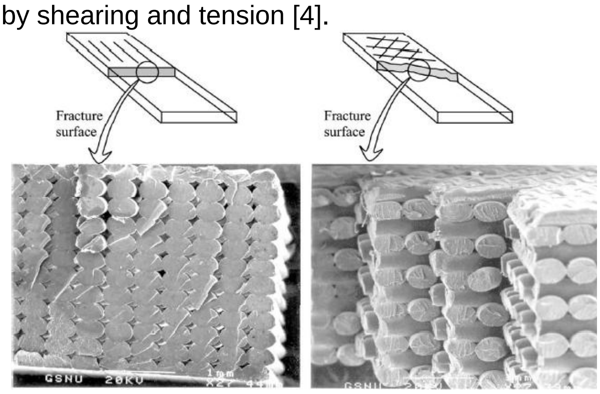

Figure 3. Fracture surfaces of $[0°]_{12}$ and $[45°/-45°]_6$ specimen [4]

3. Example of product development by FDM

Although several rapid prototyping techniques exist, all employ the same basic five-step process. The steps are:

1. Creation of CAD models of the product parts.
2. Conversion of CAD models into STL formats.
3. Use of STL files in Rapid Prototyping devices.
4. Production of the parts by one layer atop layer.
5. Cleaning of parts and assembly of the product.

In order to minimize the prototype it was decided to model the small four-graded gearbox with reverse operation and self-shift shown in Fig. 4. We did not want to design and produce any unusable parts with large surface breakdown to put it to make measurements but the prototype which would itself perform a function and was suitable for visualizing the accuracy of the printing [5].

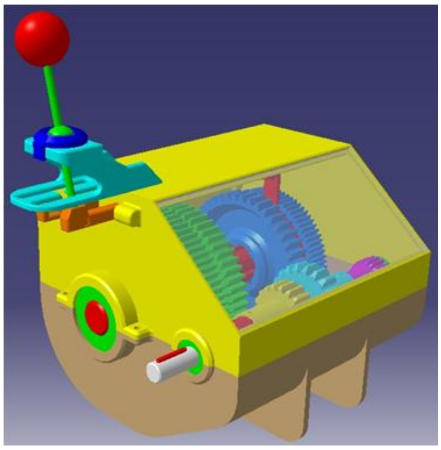

Figure 4. 3D model of the experimental gearbox

This gearbox is used only as preview tool for functional prototypes printed with FDM method and also for testing of achieved printing accuracy and quality. Gearbox has four gears, of which one is reverse. Their ratios are 4, 3, 2, and reverse gear, with fourth gear ratio. All levels are kept as transfers to slow. Because the teeth presented most accurate part of the draft, we decided to generate them using the Design Accelerator module included in Autodesk Inventor Professional 2009. This step is necessary to enter the desired parameters of gearing as a module, the distance axis, gear ratio, width of teeth and after conversion to generate a 3D model of the sprocket, which can be further modified. Model gearing was subsequently modified in CA system CATIA V5. Transfer of models between Inventor and Catia system was implemented using the exchange format IGES. In AutoCAD 2008 was ran the full dimension designing of the gear with gradually adding of proposed model arrangements through which it was possible to determine the dimensions of the gearbox. After creating of reports and rechecking of all dimensions the models were exported to STL format and sent to FDM control program that could handle their geometry [6].

On the Department of Manufacturing Technologies TU Kosice there is UPrint FDM device (Fig. 5) from Dimension available. It is a small 3D printer with 635 x 660 x 787 mm dimensions suitable for office environment. Maximum dimensions of printed prototype are 203 x 152 x 152 mm. This printer prints only one layer of constant thickness 0.254 mm which is as the accuracy of the print in the Z axis very acceptable.

Figure 5. FDM printer UPrint from Dimension

This printer use as building material thermoplastic ABCplus Ivory which comes in standardized packages as fiber with a diameter of 1.6 mm rolled onto a reel. Each spool contains 500 cubic cm of material. For this printer is used Catalyst program which serves to complete printing settings such as disposition of components on working desktop or set-saving modes where savings can be achieved by building and supporting material to 40% depending on the shape and parts at the expense of strength of the prototype. After starting of print cycle the system warms up printing jet and whole work area for working temperature. Followed by the print itself, the nozzle is moving over X-Y pad and working in the Z axis. After printing it is necessary to separate the support material from the building part [7].

Figure 6. Assembled prototype of FDM gearbox

4. Conclusion

Printing method Fused Deposition Modelling is one of the cheapest methods on market, whether it is the price of equipment or material used. Speed of devices that are used for this method and accuracy of the print is surprising but it also has some weaknesses that may not suit all users. Among the biggest weakness there is fixed thickness of the layer that can not be changed using this printer. Great layer thickness causes uncertainty in the Z axis and also affects the surface, which can be in some types of prototypes quite important, especially when it comes to functional area.

5. Acknowledgement

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WIND TURBINES INTEGRATED IN BUILDINGS

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Abstract
This paper briefly reviews the wind turbine integrated with the buildings, whether they are placed on them and the building serves as a support for the turbine or the wind generator is an integrated part of the building. The idea of installing wind turbines has its supporters and opponents, no matter what attitude to take, it is necessary to find new ways of producing energy from renewable sources, for supplies of fossil fuels are declining and their cost is becoming higher.

Keywords:
wind turbines integrated into the building

1. Introduction

At the present time the debates and discussion are being held about viability of wind. Experts have divided opinions about it and only about which they agree, is that wind turbines are cost effective and efficient if they are placed on high poles, or integrated with a facility in combination with any renewable energy source.
Wind speed increases with height so engineers came to the idea of installing wind turbines on top of buildings. Thus, the turbines can be set as independent objects on buildings and increase the usage of wind currents caused by the height. The second case is the integration of wind generation in the construction of buildings, where the building itself mounts wind turbines. The third option is the installation of wind turbines positioned between two high buildings where the form and design serves as a wind tunnel where the wind collects and directs the turbine (BAWT). Depending on the design, wind turbines can have vertical (VAWT) or horizontal (HAWT) blades.
By installing wind turbines in buildings, energy is produced where it is needed, and there is no loss of transmission and so on, but there's always that additional but. Turbines can meet about 15% of total energy demand of the building [1], everything else must be provided through other sources. By analyzing available data on the turbines and their efficiency and profitability, the results are not encouraging. The biggest problem remains the cost of investment and questionable profitability.

2. Wind turbines

Since ancient time's man used wind energy through devices integrated on the building. These wind turbines didn't produce electrical energy. As needs for energy grew as its price, an idea came to make the transfer of mechanical energy to produce electricity by the use of wind. At first the public and the profession were very skeptical about the idea of installing wind turbines on buildings, primarily looking at the profitability of investments and possible negative consequences in the event of an accident. But as time progresses and the prices of fossil fuels rise and their stocks are declining more and more countries and investors think about integrated turbines. (BUWT). So, we are witnessing the first buildings that have their own supply of electricity from wind turbines. First among them is the Bahrain World Trade Center located in Bahrain.
On this building it is possible to analyze all the arguments for and against the generator integrated into the construction of the building.

Figure 1. Bahrain World Trade Center

In addition to low efficiency and a long payback time, the problem with the wind generators is the noise that turbines make [2]. Regardless of the type of material from which the blades and the

shaft bearing are made the wind flow creates noise that can be uncomfortable no matter of the frequency. Therefore, the structures with integrated wind turbines are unoccupied around the floors where they are placed.
But if it is taken a laypersons view, each blowing of wind causes the noise. The intensity of noise generated by wind hitting the objects that get in his way (buildings, trees, etc.) depends of wind strength. Many tests were conducted on the impact of wind noise on human health. By analyzing available data on the hazards of noise from wind turbines, it leads to the conclusion that it does not pose a potential hazard to human health. If there are problems, they are on a personal level of each individual and are not applicable to the general conclusion that the noise from wind turbines is harmful [3].

After construction of the building shown in the picture, started the idea of designing buildings that will have the equipment to produce energy from renewable sources for their own use. The most known is Zero Energy Tower which is planned to be built in China. His investors (Guangdong Tobacco Company) decided to build sustainable energy skyscrapers, and for this task they have employed reputable company which designs such buildings, Skidmore, Owings & Merrill LLP [3].
The company has made a concept that wind will flow through the structure of the building and run wind turbines. And, also, solar cells will be mounted on the facade of the building. The building is still being built and we are waiting for the first feedback on the energy independence of the skyscraper.

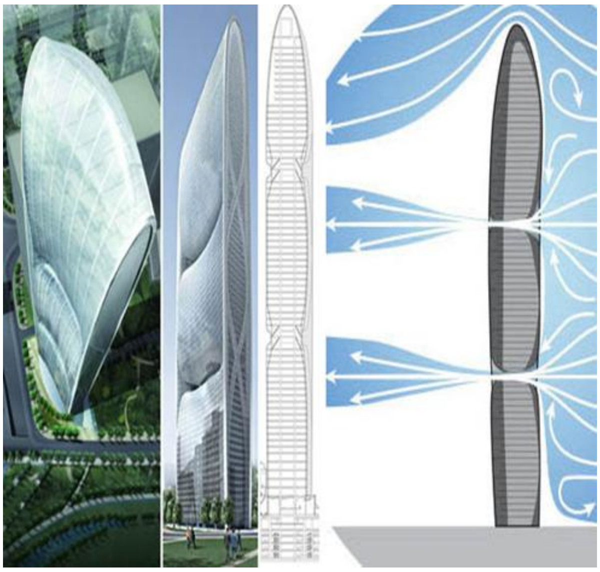

Figure 2. Guangdong Tobacco Tower in China

With the construction of the Bahrain WTC and Zero Energy Tower, architects started the era of designing skyscrapers that necessity for energy settle down from their own resources. The latest among them is the skyscraper project called "Castle House" or "Strata SE1" [4], in London. For some time now, the debate is run about cost effectiveness and efficiency of such structures, which in its structure has three integrated wind turbines, which should produce electricity for lighting and ventilation.

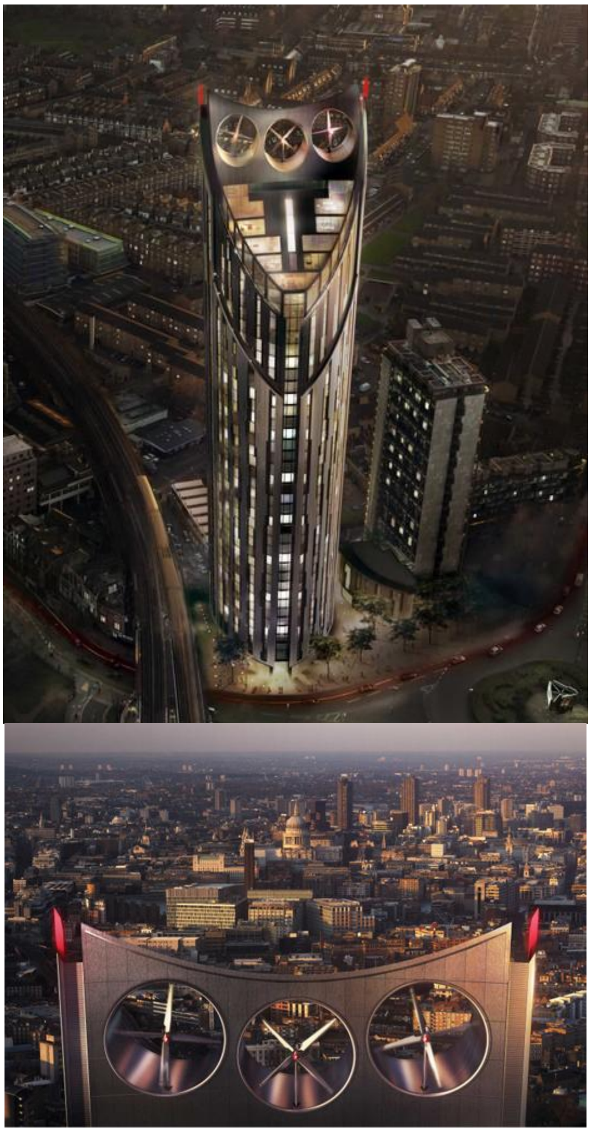

Figure 3. The Castle House, Elephant and Castle in Southwark, London

Besides the skyscrapers in the megalopolises, wind turbines are increasingly being put to great sporting facilities. This may be because a great necessity for energy is needed by such stadiums, and there is a large amount of people who visit them. In this way, running costs are reduced, but it, also, educates people and rises up awareness about renewable energy. But there are potential hazards that wind turbines represent.

An example of this is a football club Manchester City [5] that in 2006. requested permission to set up wind turbines in the stadium, but due to security reasons (ice on the blades and the threat of it) request was refused. The opposite example of this is the stadium of the University of North Texas (UNT) [6] that supports wind turbines and will provide about 6% of necessary energy. Soon, other universities and sports clubs across the United States submitted requests for placing wind turbines on their stadiums, such as a baseball stadium Cleveland State University (CSU), "The Lincoln Financial Field," in Philadelphia, a football stadium "The Riverside Stadium" in Middleborough in, North Yorkshire, England.

Figure 4. Lincoln Financial Field, Philadelphia

Besides the integration of wind turbines on buildings and sports facilities, planners and architects are considering more options. Thus recently, architects are appearing with the concepts of installing wind turbines on the roads and bridges. Also, students at Arizona University [7] proposed a set of horizontal wind turbines above the highway that will be run by wind turbulence from the vehicles. Each of the turbines by the assessment should produce about 9600 kWh of electricity annually and distribute it in the power grid. In addition to this concept, there is an idea of installing wind turbines in the construction of bridges and viaducts. One of such concepts is planned for the bridge between Italy and Scilla Bagnera [8].

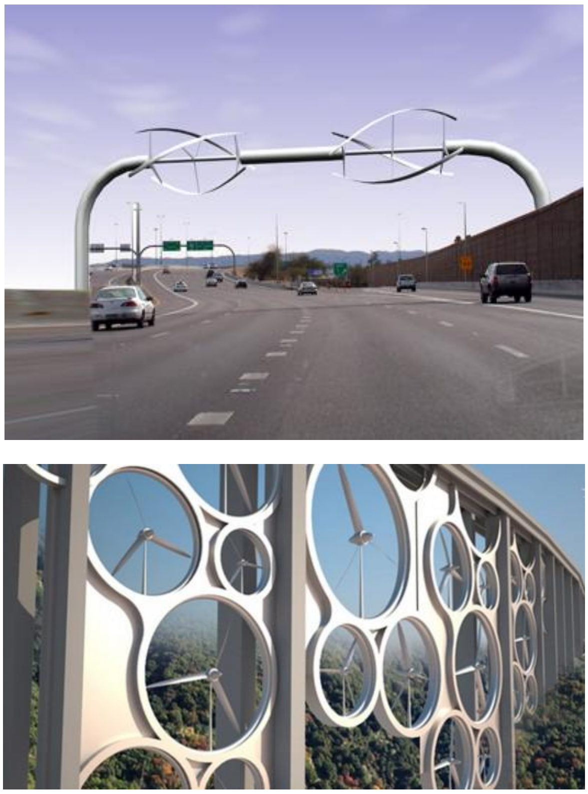

Figure 5. Horizontal wind turbine on the highway and the bridge concept, Bagnera Scilla in Italy

Looking at the idea of installing new wind turbines in all possible structures for sustainability and energy independence, it is impossible to ignore all the problems that accompany them. In addition to the long payback period and the noise, wind generators integrated in the buildings are criticized for the threat that blades potentially represents on the environment [9].
Since the blades are sometimes 30 feet long, fall down from tens of meters high, in case some of the mounting security system fails, it potentially threatens all buildings, roads and passers-by in a radius of several hundred meters. So far, there was no recorded case (or at least the producers and owners do not want them to go public with this information, if any of such cases), but there is always a potential danger.

And the fourth and the biggest problem is the fact that the rotation of the blade comes to creating vibrations [10]. The vibrations are transmitted on the building and its construction and are creating an additional burden. Many designers of these buildings discuss about this problem and how to solve it, by proposing different forms of wind turbines and their positions, but the problem still remains. The general conclusion remains that the design of buildings with turbines mounted has to

reckon with stress of vibration. If they do not pay attention to that while designing the building, it can lead to structural stress as similar to earthquake and destruction of building [11].
With the development of new technologies and materials on the market, today it can found a large number of wind turbines, which are produced from different materials. Increasingly, the market can find a wind turbine with blades made from carbon fiber and fiberglass, which when compared to those made of different aluminum alloys are a lot easier, more flexible, quieter, safer, and more expensive.

Very often can be encountered wind turbines placed for advertising purposes to show how companies are environmentally conscious or to attract attention of passers by to think about renewable energy. Thus, in Florida, all along the highway, the advertisements with turbines have been installed in order to encourage thinking about wind turbines. But on the other hand looking at the reviews of the environment, i.e. the passer bys, the most common comment is that most of the time the blades are not spinning, and their conclusion is that it might not work at all.

Figure 6. The commercial wind turbine, Florida

3. Conclusion

The amount of fossil fuels is dramatically reduced and the demand for energy grows, and thus its price. It is therefore necessary and imperative to find alternative sources of energy production. By observing and analyzing all of the above, it can be said that the need to build wind turbines installed in the building is efficient in combination with some other energy producer from renewable sources such as solar panels or heat pumps. When we consider the climate and the winds that blow in Croatia, the installation of wind power in the building is an option in the coastal area.

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INTERPOLATION OF 2D TRAJECTORY

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Abstract
The article deals with methods of linear and circular interpolation of trajectory for 2D motion device created by a cross-table. The interpolators suitable for chosen trajectories are the means of the demonstration trajectory interpolation. For evaluation of generated trajectories quality, the ideal, interpolated and generated trajectories are compared in regard to the deviation between each other.

Keywords:
Linear trajectory, circular trajectory, interpolation, trajectory generation.

1. Introduction

The interpolation of desired trajectory has an importance at generation of a trajectory in defined shape, whereby its accuracy and approximation to the original trajectory are the most important requirements. A lot of authors deals with the problematic of smooth trajectory generation for manipulation devices in real time and with the pre-processing of information necessary to generation of defined trajectory. They use the innovative methods such as artificial intelligence, evolutional algorithms [1] and neural networks [4] suitable for determined problematic.

2. Experimental device

The cross-table represents an experimental device used for generation of examined trajectories. Designed interpolation algorithms are derived according to computation requirements of used relations, available control electronics as well as possibilities of parameterisation of action variables for speed control.
Two positioning blocks for the movement in x and y direction create the main part of experimental cross-table. They are placed at each other by that way that the block for translation in y direction represents the bottom part and drags the top one. Translation movement is created by DC motors HSM60 together with elastic couplings, endless screws, and linear sliding by means of radial bearings.
The control hardware is created by power source, power circuit, and circuit for processing of signals from sensors. The pulse transistor converters in H-bridge circuit represent the supplying of DC motors armature using the controlled average value of supply voltage by the pulse width modulation. The control system is realized by the ARM processor and evaluation board.

3. Digital differential analysis

The value of action variable, expressing the speed of movement, is calculated on the basis of coordinates' difference between actual and next node point. Analytical describing of a line can be modify by means of differential form and appropriate increments into

$$x = \sum k_x \Delta t, \quad y = \sum k_y \Delta t. \tag{1}$$

For calculation of point coordinates, the value of difference between two node points has to be known. Values k_x and k_y expressly determine the slope of linear subinterval; parameter Δt determines the speed of movement and is limited by system's features.
The deviations of generated trajectories are better noticeable at short linear sections, therefore, by experimental approach, the generated linear sections with constant duty ratio of PWM in x-direction were compared. Generated trajectories with regression equations and coefficients of reliability are displayed in the figure 1; the error of appropriate trajectories is displayed in the figure 2.

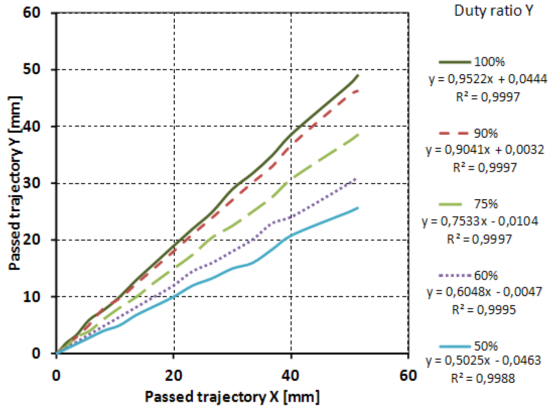

Figure 1 Generated trajectories

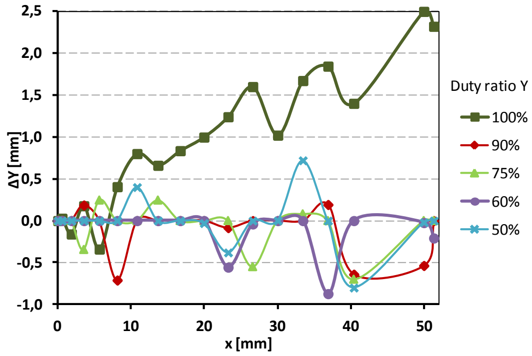

Figure 2 Error of generated trajectories

DDA method allows to generate a circle that consists of linear sections which length is determined by desired accuracy of circular shape of trajectory as well as by translation speed of mechanical system according to control system.
The process of appropriate increments derivation is similar to line generation. It is appeared from analytical describing of coordinates of circle points:

$$x = R \cdot \cos t, \quad y = R \cdot \sin t, \tag{2}$$

where t is the time interval that represents the speed of movement and has a form of angular increment between two neighbouring points on the circle. The lesser this parameter is, the more accurate the circular interpolation is.
For increments in appropriate axis, it can be written

$$\Delta x = -y\ \Delta t, \quad \Delta y = x\ \Delta t. \tag{3}$$

Resultant relation for increments represents unassuming calculation, their value is given by both the actual coordinates of i-point on the circular trajectory [x_i, y_i] and the time interval Δt, whereby the coordinate y determines the increment in x-axis.

4. Computing interpolation method

The fundament of this method is to compute the variable D according to the known analytical description of trajectory. If $D > 0$, so the actual position X is increased by elementary increment, if $D < 0$, so the actual position Y is increased [2]. At initial position, if the start point of generated trajectory is simultaneously the first point of interpolated trajectory, it is necessary to decide what direction the first increment should be generated in.
In the figure 3 there is displayed the common principle of this method.

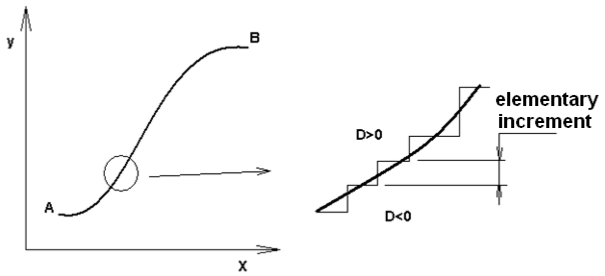

Figure 3 Computing interpolation method

For circle generation by this interpolation method it is necessary to know the equation of the circle, i.e. its radius and, as it arises from the technique of this interpolation, the step that the circle is interpolated with.
Analytical describing of circular trajectory is given by equation

$$x^2 + y^2 = R^2 \Rightarrow x^2 + y^2 - R^2 = 0. \tag{4}$$

At time t it can be written:

$$x_t^2 + y_t^2 - R^2 = D_t. \tag{5}$$

If the increment Δx is sent at time $t + \Delta t$, the equation changes

$$(x_t + \Delta x)^2 + y_t^2 - R^2 = D_{t+1}, \tag{6}$$

and after substitution

$$D_{t+1} = D_t + 2\Delta x + \Delta x^2. \tag{7}$$

If the increment Δy is sent, the following equation can be obtained:

$$D_{t+1} = D_t + 2\Delta y + \Delta y^2. \tag{8}$$

It is found out that the values $\pm 2x + 1$ for Δx increment and $\pm 2y + 1$ for Δy increment are sufficient for practical applications. The sign of summation or subtraction is determined by the quadrant that appropriate circular arc is situated in.
At this interpolation method, the radius R of the circular trajectory and the value that is incremented in appropriate directions have to be selected.
For a real generated trajectory by means of cross-table there are selected interpolation parameters as follows: circle radius R = 40 mm, increment Δx = Δy = 0,2 mm, centre of circle lies on the point [0,0]. Generation of circular arc only in one quadrant of coordinate system allows better reading of resultant trajectory, therefore the generation in the 1. quadrant is selected. Resultant trajectory is displayed in the figure 4; passed trajectories in particular axis as time functions are displayed in the figure 5.

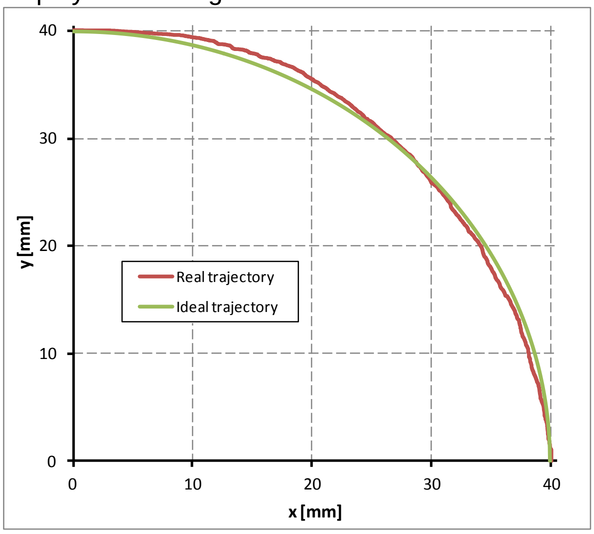

Figure 4 Generated trajectory

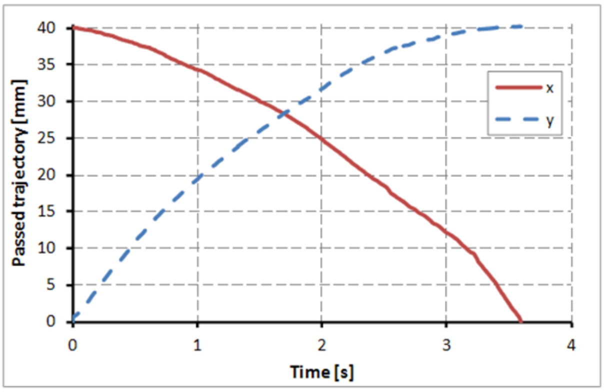

Figure 5 Displacement X and Y dependent on time

In the figure 6 there are displayed deviances of generated really passed trajectory from an ideal one.

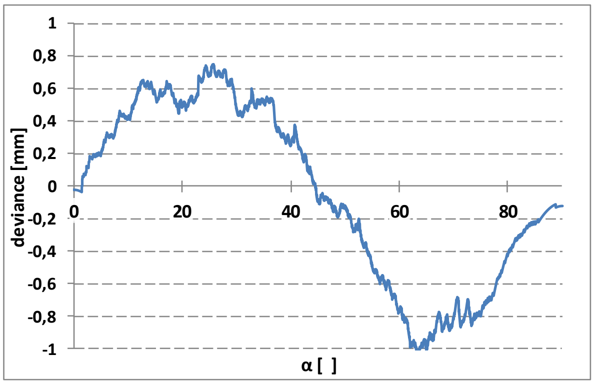

Figure 6 Deviance from an ideal circle

5. Circular interpolation with constant step X_K

This interpolation method is based on constant speed in x direction; the speed in y direction is variable. The circle is substituted by linear sections with variable slope that defines the speed in y direction (figure 7).

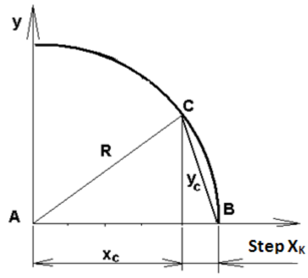

Figure 7 Constant length step

The linear section BC is determined by coordinates of points B[R, 0] and C[x_C, y_C], whereby:

$$x_C = R - iX_K, \tag{9}$$

$$y_C = \sqrt{R^2 - x_C^2}, \tag{10}$$

where i is the number of section.

For the real experiment, the step X_K is set to 4 mm, circle radius R is 40 mm. Relative speeds, computed with regards to both the slope of linear sections and the maximal speed v_y, are displayed in the figure 8. Generated and ideal trajectories and their deviance are displayed in the figure 9 and 10.

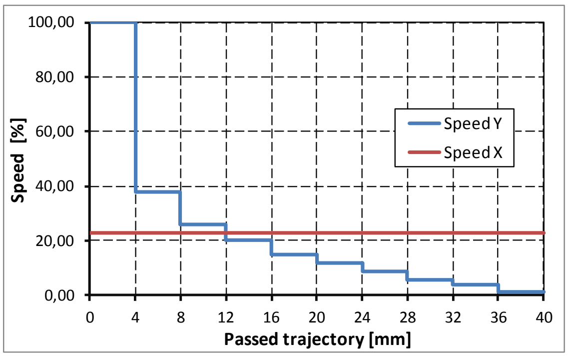

Figure 8 Parameterisated speed vy

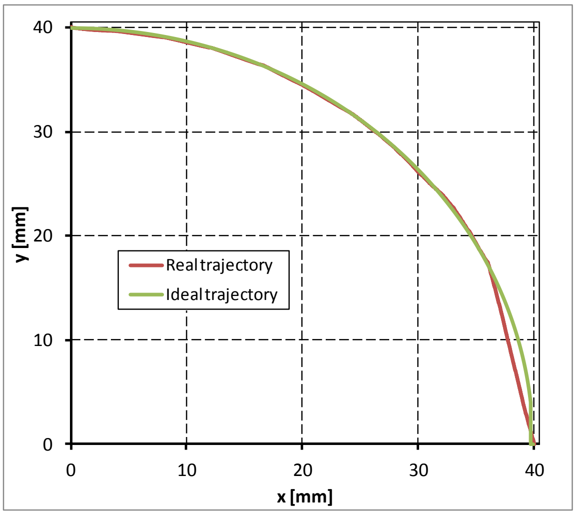

Figure 9 Generated trajectory

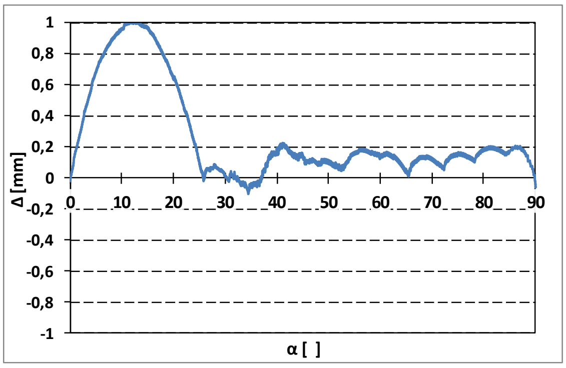

Figure 10 Deviance of real and ideal trajectory

Maximal deviance 1 mm originated on the first linear subinterval; the deviance on the others subintervals is in the range from -0.1 to 0.2 mm.

6. Circular interpolation with constant deviance

In this case, the deviance δ is defined and end points of linear subsections are not placed on interpolated circle but on the circles expressing this deviance. It is supposed that the upper and lower deviance have the same size (figure 11).

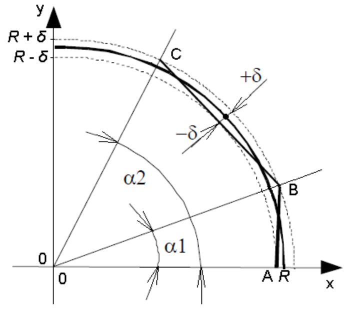

Figure 11 Constant deviance

The interpolation subsections are given by the size of deviance δ, that determines the circular arc with the chord length

$$t = 2\sqrt{\delta(2R-\delta)}. \tag{11}$$

The angle, which this chord determines on the circle with diameter R, can be computed as follows

$$\alpha = \alpha_1 = 2\arcsin\frac{t}{2R}, \tag{12}$$

what is angular increment. Therefore, the coordinates of appropriate points are

$$x_i = R\cos\alpha_i, \tag{13}$$

$$y_i = R\sin\alpha_i, \tag{14}$$

Generated and ideal trajectory with diameter R = 40 mm and desired maximal deviance δ = 1 mm are displayed in the figure 12, the deviances of particular trajectories in the figure 13.

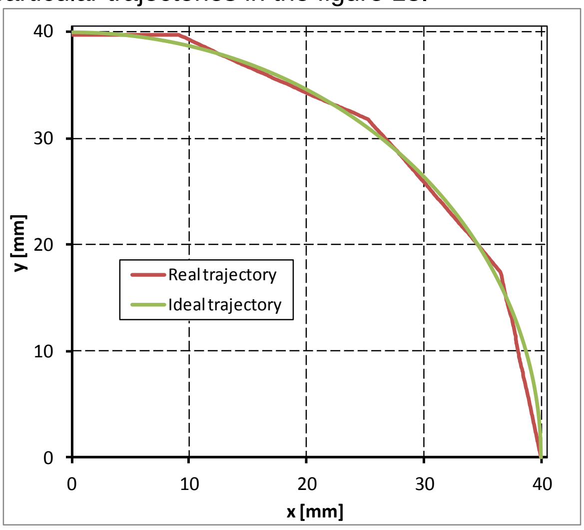

Figure 12 Generated trajectory

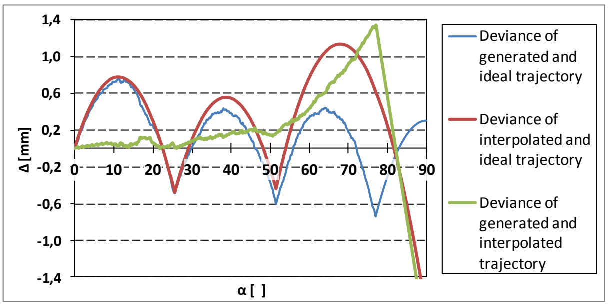

Figure 13 Deviances of trajectories

From the deviance curve of generated and ideal trajectory it is evident that assessed maximal deviance was observed. The deviance curve of interpolated and ideal trajectory shows that interpolated trajectory has greater deviance than was desired. However, this deviance does not affect the real generated trajectory, what is caused by mechanical properties of laboratory model components, time sequence of control program, and time delay at computing of manipulated variable size by numerical controller.

7. Conclusion

Demonstration interpolated trajectories were chosen in regard of pointing to the differences between particular generation algorithms. By comparison it was found out that the algorithms of constant step X_K and constant deviance δ have the maximum deviance from the ideal state. Decreasing of defining parameters would lead to their minimisation. In the further research, the deliberation of continuity of neighbouring sections has considerable importance, what has an influence on smoothness of resultant trajectory.
Improvement of accuracy can be ensured by faster communication and data transmission from incremental position sensors, e.g. by wireless technology [3], or their faster processing in control computer.

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OIL FLOW THROUGH THE SLIDING BEARING

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Abstract
Function and lifetime of a lubricated sliding bearing depends on the flow rate of the oil (bulk flow) and the size of the inlet pressure. In this paper, we compare the computed standardized values of required oil flow rate to experimentally observed results for the radial sliding bearing that is statically loaded on the Tribotester. The flow rate is determined depending on the inlet pressure and position of lubricant gap considering the external loading force, set by the angle γ [1].

Keywords:
sliding bearing, oil flow rate, pressure of oil, lubricant coating, Sommerfeld number

1. Introduction
Almost all machinery includes rotating parts that are stored in the bearings. The role of the mounting is to allow relative movement of the machine parts that transmit static, quasi-static or dynamic loads. One of the basic types of storage is the one used by the radial sliding bearings [2].
It is necessary to properly design and operate the sliding bearing to fulfill the desired function during its life. Theoretical design of the radial sliding bearings is given in the standard STN 02 3400, the standard ISO/DIS 7902 and other related technical standards and regulations. An important requirement for the proper function of the bearing during its operation is sufficient lubrication with a suitable lubricant. Many researchers are concerned about the theoretical solutions of hydrodynamic lubrication of the radial slide bearing. Their findings were published and are being published in a number of theoretical works. All of the works just evade, or only very generally deal with the volume flow of lubricating oil in the bearing [3]. The bulk quantity of oil that is necessary to transport to the bearings under certain pressure is proposed by the theoretical calculation according to certain regulations. The required values of respective quantities are being instated from the diagrams in the standard during the computation. This leads to some inaccuracies in determining the actual requirement of the oil volume flow through the bearing.

2. Method
The aim of this paper is to compare the calculated necessary volume flow rate of the oil based on the technical rules with the experimentally determined volume flows of oil. The following is compared: selected radial sliding bearings, oil inlet pressures and the position of the entry of oil into the bearing.
The theoretical needed oil bulk flow (flow rate) consists of parts of side outflow. After summation of these factors the total flow rate is:

$$Q = \frac{d^3 \cdot \psi_e \left(R_1 \cdot b \cdot \varepsilon \cdot \eta \cdot \omega + S \cdot d \cdot p_0 \cdot \psi_e^2 \right)}{8 \cdot b \cdot \eta} \qquad (1)$$

,

where:
- d nominal pin diameter (m),
- ψ_e hydrodynamically effective relative bearing clearance,
- R_1 characteristic number of side outflow,
- b width of bearing (m),
- ε relative eccentricity of pin,
- η dynamical viscosity of oil (Pa.s),
- ω angular velocity (rad.s^{-1}),
- S characteristic inflow number,
- p_0 inlet oil pressure (Pa).

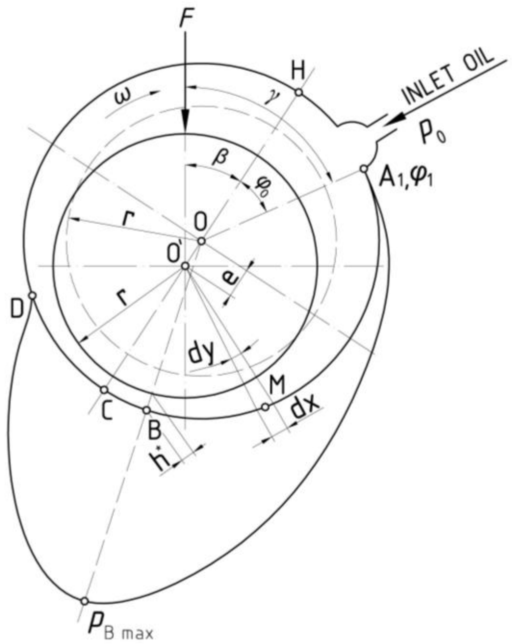

Figure 1. Distribution of Oil Pressure in Sliding Bearing

Direct measurement of oil flow, that flows out through front of the bearing is very inaccurate. There is uncontrolled dispersion of oil into the

environment. This is the reason why the method of measuring the interval, during which the predetermined volume of oil is transported to the bearing, was used. Accuracy of such measuring method of flow rate is severalfold higher.
The basic element of the measurement was the transparent glassy cylinder with the calibrated inner diameter, that was filled with oil. The transparent cylinder allowed us to adjust by the amount of the oil column scale. The oil column represented the predetermined volume of oil transported into the bearing.
The volume flow of oil through the bearing depends upon non-dimensional Sommerfeld number S_{oD}. This number characterizes the size of bearing, its load, angular velocity of pin rotation, relative bearing clearance and dynamic viscosity of oil. The bearings with parameters according to Table 1 were chosen for the experiments.

Table 1. Parameters of the Test Bearings

No. Bearing	Nominal Dimensions *b*/*d* (mm)	Average Bearing Clearance (μm)	Sommerfeld number S_{oD}
I.	20/16	35	1,35 ÷ 1,58
II.	32/40	50	1,8 ÷ 2,45
III.	47,2/59	70	3,6 ÷ 3,8
IV.	64/80	73	3,75 ÷ 4,5
V.	80/100	88	4,7 ÷ 5,3

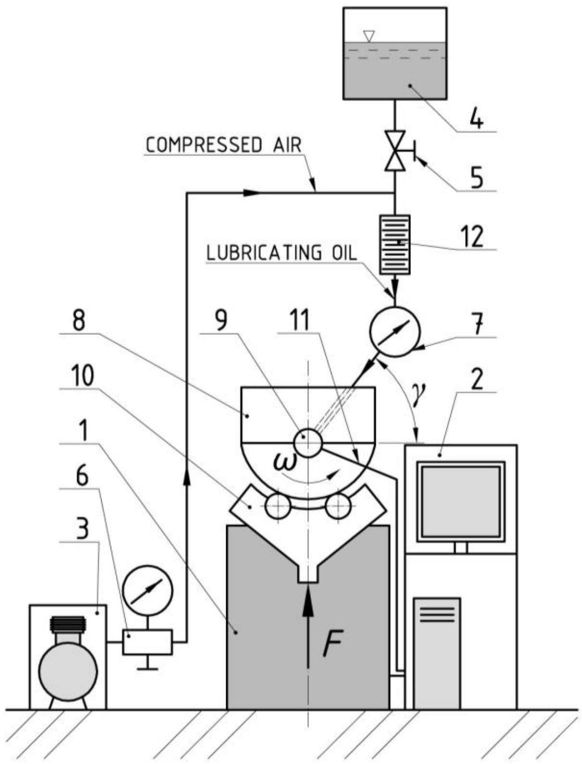

Figure 2. Schematic View of Testing Device

Legend to Figure 1:
1 Tribotester
2 Control unit
3 Source of compressed air
4 Storage tank of oil
5 Stop valve of oil
6 Reducing air valve
7 Control manometer
8 Split grip holder
9 Pin bearing test
10 Loading of bearing
11 Temperature sensor
12 Calibrated measuring glass cylinder

The choice of bearings was adjusted to meet the requirement that the range of S_{oD} had to be the biggest (1,35 ÷ 5,3) as far as it was possible with the experimental equipment that was used.
The pins of the bearings were made from steel St50 2, the bearing shells from material CuSn10P1. Average arithmetical abrasiveness of pins was R_{aH} = 0,09 μm, and for bearing shells it was R_{aL} = 0,5 μm.
High-grade bearing oil OL-J3 (ISO VG3) was used as the lubricating medium. It is highly refined oil that contains antifoaming additives and antioxidants in compliance with DIN 51 502:C. The oil was transported into the bearings by standalone lubricant gap. The experiments were performed for oil inlet under angle of γ = 0º, γ = 45º and γ = 60º. The angle was given by the resultant of outer load in the direction of pin rotation. The measurement was performed for the inlet pressures of oil into the bearing of p_0 = 0,2 MPa, p_0 = 0,4 MPa and p_0 = 0,6 MPa.

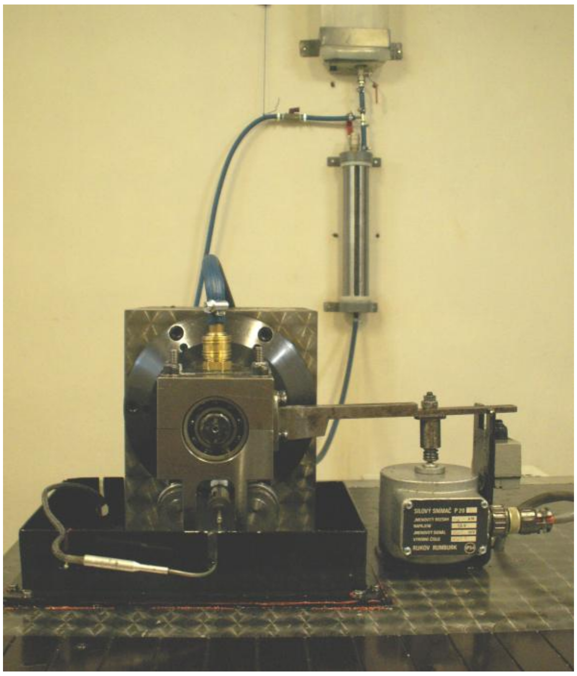

Figure 3. Split Grip Holder of Tribotester

The bearings were loaded with force of 1 471 N. Angular velocity of pins rotation in the bushings was ω = 83,776 rad.s^{-1}.

3. Results

The measured values were statistically processed. Figures 4, 5 and 6 graphically present the biggest differences between theoretical calculation and experiment.

The deviation angle of oil inlet γ = 0º:

Theoretically calculated values of flow rate, when S_{oD} < 3 and p_0 = 0,2 MPa, are lower than experimentally measured. For S_{oD} > 3, the results are opposite.

For pressure of 0,4 MPa and S_{oD} < 3,2 the calculated values are somewhat smaller than experimentally measured. For S_{oD} > 3,2 the results are opposite and the differences are bigger.

The calculated values for p_0 = 0,6 MPa and S_{oD} < 3,6 are moderately smaller than measured. For S_{oD} > 3,6 the opposite is true, but the differences are considerably smaller than with the previous pressure.

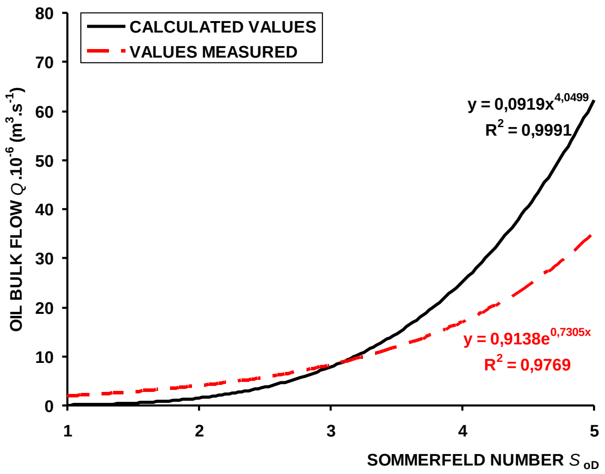

Figure 4. Dependence of Volume Flow Rate in S_{oD} , γ = 0º , p_0 = 0,2 MPa

The deviation angle of oil inlet γ = 45º:

There is match for S_{oD} = 3,5. For S_{oD} > 3,5 and

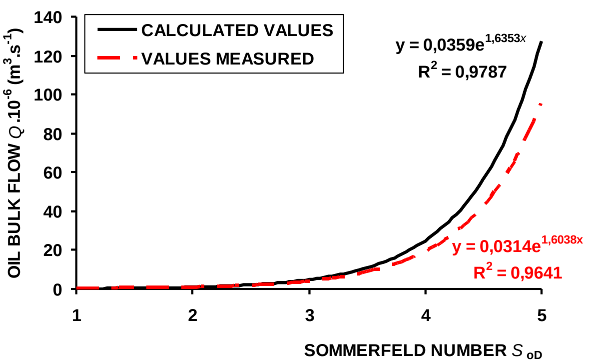

Figure 5. *Dependence of Volume Flow Rate in S_{oD} , γ = 45º , p_0 = 0,2* MPa

pressure p_0 = 0,2 MPa, the theoretical values of flow rate are bigger than measured. The differences are much smaller than with value of 0º.

The same conformity as in the previous case is for S_{oD} < 4,5 for pressure of 0,4 MPa. If S_{oD} > 4,5 then the computed values are higher, but the difference is smaller than the previous.

When pressure p_0 = 0,6 MPa, there is very good congruence of experiment with theory within the whole monitored range of S_{oD}.

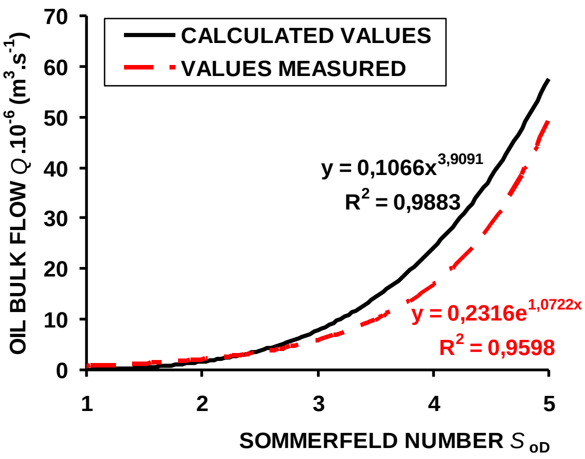

Figure 6. Dependence of Volume Flow Rate in S_{oD} , γ = 60º , p_0 = 0,2 MPa

The deviation angle of oil inlet γ = 60º:

The calculated values for S_{oD} < 2,5 and p_0 = 0,2 MPa are lower than in experiment. If S_{oD} > 2,5 the situation is reversed and differences are significantly bigger. The contrasts begin to decrease from the value of S_{oD} ≈ 5.

If S_{oD} < 4,5 and p_0 = 0,4 MPa the differences of values are very small and for higher $S_{oD,}$ the theoretical values are smaller than the experimental. The contrasts are lesser than in the previous case.

For S_{oD} < 4,3 and p_0 = 0,6 MPa the differences are minor and above the value 4,3 they are greater than theoretical. Generally, they are smaller than in the previous case.

4. Discussion

We can summarize the experiments performed on the Tribotester compared to the calculations into the following facts so far.

First, the bulk flow of lubricating oil depends on S_{oD} value and its gain causes the rate increase according to exponential or power dependence.

Furthermore, the deviation angle of oil inlet into the bearing from the external load affects the oil bulk flow as well. The maximal values for the bulk flow attained by calculation were proven also experimentally for angle γ = 45°, minimal values for γ = 60°.

Moreover, the oil bulk flow is considerably affected by the inlet pressure p_0, by which this is conveyed into the bearing. There is an increase of the bulk flow caused by the accrual of pressure.

The best equality between the experimental and the calculated results was recorded for angle γ = 0°, with inlet pressure of p_0 = 0,6 MPa and S_{oD} < 3,5. Greater aberrations were recorded for S_{oD} > 3,5. The aberrations for inlet pressure p_0 = 0,2 MPa are the highest within the range of S_{oD}.

In case of γ = 45° and lubricating oil inlet pressures of p_0 = 0,4 MPa and 0,6 MPa, very good accordance of results was detected within the whole monitored range of S_{oD}. There was accordance for p_0 = 0,2 MPa noticed only for S_{oD} < 2,6. The difference between the experimental and the calculated values of bulk flow for S_{oD} > 2,6 was rising. It acquired its highest values for S_{oD} = 5,2.

Fair accordance of results in the case of γ = 60° and inlet pressures of p_0 = 0,4 and p_0 = 0,6 MPa was detected for S_{oD} < 4,5. The difference between the calculated and experimentally measured values of the oil bulk flow increased with rising value of S_{oD}. There was relatively big difference between values of the bulk flow for p_0 = 0,2 MPa within the whole range of S_{oD}.

From the stated facts, it can be concluded that the best equality was maintained for every angle with higher inlet pressure of the lubricating oil. In case of p_0 = 0,2 MPa, there were detected some differences, in some instances higher than 50%, for lower values of S_{oD}. It results from the presumption that if p_0 < 0,4 Mpa, then the bearing space is not coherently filled with the lubricating oil. Except for some cases, the calculated values of the oil bulk flow were higher than experimentally detected. It means that theoretical solution shows certain safety that comes from the higher flow rate as the experimentally reached reality. There is no limit friction. The liquid friction is secured during the operation, which is the inevitable precondition of right function of the hydrodynamically lubricated sliding bearings.

The maximal values for the bulk flow of lubricating oil were recorded for γ = 45°. Therefore, the angle of γ = 45° is recommended for use when increased temperature of the bearing is expected, for instance due to the environmental conditions. Greater oil bulk flow ensures better heat removal from the bearing [4].

5. Conclusion

When designing a radial sliding bearing, it is therefore very important to design the flow rate of lubricating oil and the size of inlet pressure. Proper functioning of the radial sliding bearing depends on these quantities [5].

It is possible to define the actual required capacity of oil transported to the bearing by researching the flow rate. The purpose is to achieve hydrodynamical lubrication. For proper functioning, it is necessary to transport the lubricating oil into the bearing under certain pressure. The integrity of lubricating film on the contact surface of bearing depends upon the inlet pressure [6]. The achievement of liquid friction in the whole bearing is unconditionally necessary for formation of hydrodynamical lubrication.

Moreover, the amount of exhaust heat depends on the volume of oil, which is being transported into the bearing. This amount of exhaust heat by excurrent oil affects the total temperature of oil layer. Viscosity depends on this layer, which influences the load capacity of bearing. Total temperature of the bearing also depends upon this layer. It has direct influence on the safety in operation and bearing life. It affects the bearing clearance, as well. The bearing clearance interrelates with the precision of mounting sliding of machine parts.

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DIFFERENTIAL SCANNING CALORIMETRY AND THERMOGRAVIMETRIC ANALYSIS AS A STARTING POINT FOR OPTIMIZATION OF PLASTICS PROCESSING

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Abstract

Plastics have various thermal stabilities that are depending on the structure of polymers chains. Therefore is very important to know these properties, which influences temperature regime processing equipments. In this contribution are presented examples differential scanning analysis (DSC) and thermogravimetry analysis (TG) of selected plastics in protective atmosphere of Ar as well as in oxidative atmosphere of synthetic air. These analyses serve for proposition of temperature regime of processing.

Keywords:

plastics, polymers, processing, differential scanning calorimetry, thermogravimetric analysis

1. Introduction

The importance of polymers lies in distinct advantages that they offer. These advantages include: light weight, good thermal and electrical insulation properties, resistance to corrosion effects, chemically inert, high strength and dimensional stability, absorption of mechanical shocks, good dyeability, potential for decorative surface effects, low production costs [1].

Future progress in polymer technology may depend mainly on the same factors that produced the recent fast growth. Some of the main factors include [2]:

- Improved understanding of polymer characteristics, especially long-term and under combined stresses (that is, under combined mechanical, thermal, and chemical effects).
- Development and utilization of new materials and combinations of materials, especially in reinforced plastics or composites. Steady reduction in materials costs relative to competing materials, taking advantage of low energy requirements for processing, and economies of scale.
- Invention and commercialization of new processes.
- Continued improvement in quality, in part due to further automation and in-line measurement and control.
- Advancement in recycling technology to reduce environmental consequences of wider use of nondegradable materials.

One of the first steps in polymer product design is selection of candidate materials by the design engineer, in cooperation with production engineers, toolmakers, and marketing personnel. Therefore, an understanding of the chemistry of polymers, and the additives used to modify their properties, is essential for good communication between all of the key personnel involved. This is especially true in the evaluation and exploitation of a new polymer of polymer alloy, where the user must consider chemical composition, as it reflects on the performance of any product that is being promoted for public use. The user must also consider the effects of chemical composition on safety in processing, waste disposal, and durability in all sorts of environments. A similar relationship between product and material exists in all technologies; e.g., a machine shop supervisor must know enough about metallurgy to recognize when there is a metallurgical problem and be able to exchange information intelligently with metallurgical experts [2].

During their production, processing and application, polymers are often subjected to temperature-dependent structural changes. Thermal analysis for characterization of polymers is widely practiced today in research and industry [1].

There are three different basic thermal analysis techniques: differential scanning calorimetry (DSC), thermogravimetric analysis (TG) and thermomechanical analysis (TMA) [2].

DSC instruments are widely used for the thermal characterization of polymers [3]. DSC is a technique that measures heat flow into or out of a material as a function of time or temperature. The required sample size is relatively small and very little sample preparation is required which translate to fast analysis time. In a DSC measurement, information about thermal and mechanical history (processing influences, crystallinity and curing, service temperature) is revealed by the first heating curve and for forensic comparison of chemically similar samples thermal history plays an important role because subsequent controlled cooling creates a ‘‘new’’ known specimen history, which gives same characteristic properties to all materials [4]. The advantage of DSC compared with other calorimetric techniques lies in the broad dynamic range regarding heating and cooling rates, including isothermal and temperature-modulated operation [5]. DSC is a useful tool for characterizing thermoplastics by determining the glass transition temperatures. This technique is especially useful in the characterization of copolymers and blends where this information may be directly applied to determining the formulation changes required to improve physical properties [6, 7].

2. Method

Differential scanning calorimetry (DSC) and thermogravimetry (TG) measurements were employed in this study. Both measurements were performed on a Netzsch STA 409CD Simultaneous Thermal Analysis Apparatus (fig.1). This instrument is able to record both measured values (DSC and TG) in same time.

Figure 1. Netzsch STA 409CD – Simultaneous Thermal Analysis Apparatus

The samples were tested at non-isothermal conditions at the same scanning rates of 10K/min in two steps: heating and cooling. The temperature range of measurement was from room temperature to 350°C. Each specimen, i.e. Polyactic Acid (PLA) and High Density Polyethylene (HDPE) was measured in inert and also in oxidizing atmosphere.

First measurements were conducted in protective atmosphere of pure Ar (99,9999 vol.%). The evacuation and purification of furnace by Ar was done before measurements. The gas flow of Ar during measurement was 60 ml/min.

Measurements in oxidizing atmosphere were conducted in static air in furnace without active gas flow.

Samples were loaded onto an aluminium pan covered by aluminium lid. The weight of samples varied between 3,9 mg and 8,7 mg.

The thermal properties such as glass transition temperature (Tg), melting temperature (Tm) and solidification temperature (Ts) were measured. The thermal stability of the samples was investigated with a TG.

3. Results

In Fig. 2 is the DSC-TG result of PLA sample (6,5mg) tested in Ar protective atmosphere. The mass of PLA sample for DSC-TG measurement in the static air atmosphere was 3,9 mg. In the Fig. 3 is DCS-TG record (heating and cooling) of this sample in axis of TG (left), DCS (right) plotted against Time.

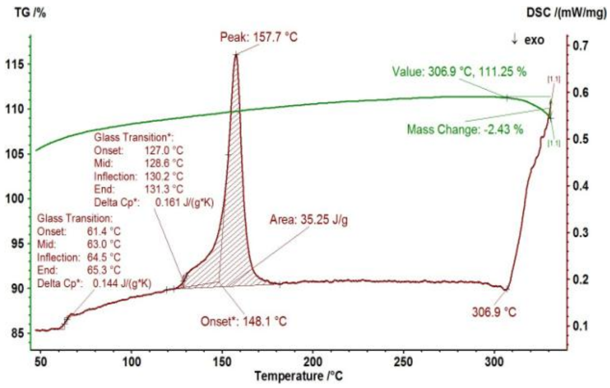

Figure 2. DSC-TG record of PLA (6,5mg) measured in argon

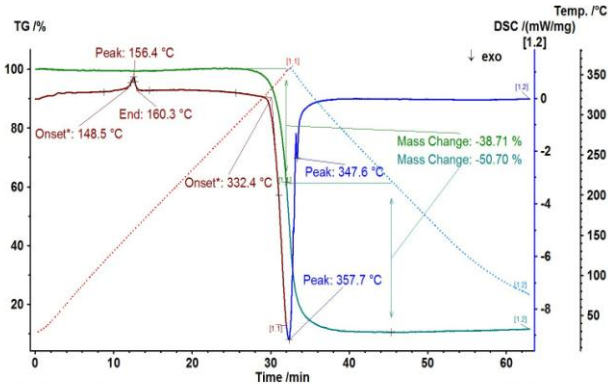

Figure 3. DSC-TG record of PLA (3,9 mg) measured in air

The DSC-TG result of HDPE sample (4,5mg) tested in Ar protective atmosphere is in Fig. 4. The weight of HDPE sample for DSC-TG measurement in the static air atmosphere was 3,8 mg. The DCS-TG record (heating and cooling) is in the Fig.5. Axes are again in the TG (left), DSC (right) versus Time coordinates.

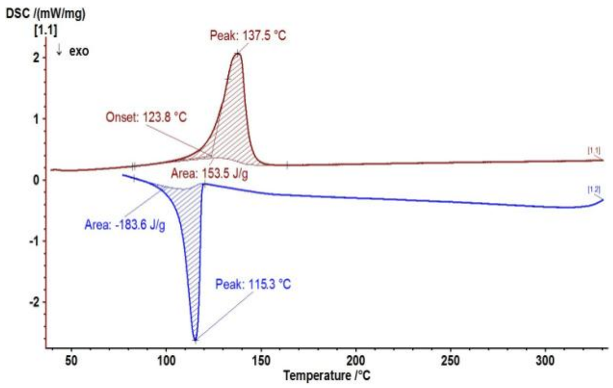

Figure 4. DSC-TG record of HDPE (4,5mg) measured in argon

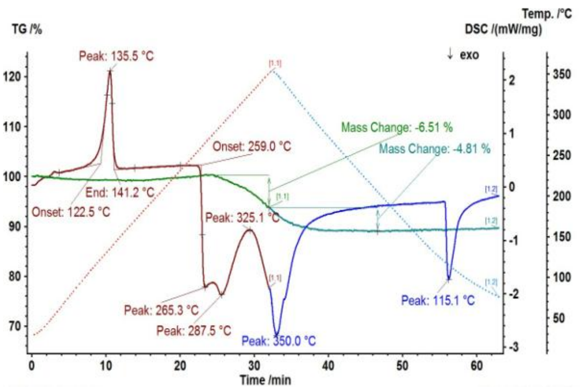

Figure 5. DSC-TG record of HDPE (3,8mg) measured in air

4. Discussion

Red DSC curve (PLA sample in fig. 2) shows only endothermic changes in sample during heating (10K/min). Glass transition occurred around 61,4°C and complete transformation finished at 65,3°C. The sample started to melt at 127,0°C, however the shape of melting peak indicated that the major components of sample started to melt at higher temperature 148,1°C. Sample was completely melted at around 180°C. The specific heat required for melting was 35,25 J/g. The melted sample was stable during further heating until the temperature of 306,9°C had been reached. After this temperature the sample showed endothermic reaction which seems to be unfinished at 330°C. Green curve represents TG signal without correction to the empty pans. That is why the slope appears on it. However at same temperature of 306,9°C as the endothermic signal increases, the TG signal starts to detect the mass loss. These results suggesting that decomposition of this sample started at 306,9°C. During cooling no exothermic or endhotermic reactions were recorded.

The temperature in fig. 3 can be read at any time on the dotted linear lines (red in case of heating and blue at cooling). Melting of the main composition of the sample occurred at similar temperature (148,5°C) as in previous measurement in the Ar dynamic atmosphere. Over 310°C the sample starts slightly lose its weight, but at 332,4°C it started lose weight dramatically, followed by huge exothermic reaction, which is probably burning of the sample. This exothermic reaction has not finished during heating, but continues also at cooling while whole sample is burn out. After that the DSC and TG signals return to the straight lines till is sample is cooled down to the room temperature. The total mass loss of sample is 89,41%.

Red DSC curve in fig. 4 (HDPE sample) shows again only endothermic changes in sample during heating (10K/min). The sample started to melt about 100°C; however the major components of sample started to melt at higher temperature 123,8°C and sample was completely melted at 137,5°C. The specific heat required for melting was 153,5J/g. The melted sample was stable during further heating. During cooling has occurred exothermic reaction at 115,3°C.

In fig. 5 is shown that melting of this sample started at 122,5°C at measurement in air atmosphere. However at 259°C occurred exothermic reactions at least in three steps related with mass loss of about 11,3%. In DSC cooling curve is shown exothermic reaction representing solidification at 115,1°C. This measurement shows that during heating at air atmosphere occurred both, melting reaction and oxidative degradation of HDPE sample.

5. Conclusions

In this contribution was present that simultaneous TG-DSC measurements can be utilized for determination of melting temperatures as well as for determination of thermal degradation in protective atmosphere and thermal oxidation in air atmosphere during heating.

These measured values can determine optimal temperature parameters of plastic processing technologies, i.e. extrusion, injection moulding, blow moulding and rotation moulding.

It was found that PLA degrade in both measurements, in Ar protective atmosphere as well as in air oxidizing atmosphere. In other hand the HDPE is much stable, during heating in Ar atmosphere does not occurred any exo or endo reaction or mass loss.

The difference of those two polymers is connected with diverse of their macromolecular structures.

The results showed that this method is suitable for further evaluation of rheological properties, especially the temperature range of polymers thermal stability. Through this method the influence of additions to the temperature tracking could be determined. The present measurement results are an important parameter for next treatment of polymers.

6. Acknowledgement

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FACILITIES OF OPTIMIZATION OF THIN-WALLED CONSTRUCTIONS IN CAE SYSTEM ANSYS

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Abstract
Solving optimization problems from the standpoint of construction stress and deformations can be carried out scientifically also on the telescopic jib. It is mainly due to the fact that despite a broad spectrum of the telescopic jib utilisation there are no generally valid, scientifically proven and presented theoretical principles for their designing. From the viewpoint of the classification of mechanics, the arm of telescopic jib as a subject of study can be ranked among thin-walled constructions. In fact, it is a case of enclosed thin-walled bars stressed in operation by a combination of bending and torsion moments. Applying the Finite Element Method (FEM) in connection with the CAE system ANSYS, it is possible to design an optimum shape of the cross-section of the telescopic jib arm. Comparing the calculated values of stresses and deformations with the values obtained by experimental measuring, it is possible to evaluate the effectiveness of the optimization process.

Keywords:
optimization, Finite Element Method, thin-walled constructions, CAE system, ANSYS

1. Introduction

The telescopic jib presents a unique design solution through which it is possible to reach a wide range of work positions of the equipment at a high accuracy of the work cycle. Its universal utilisation is just that feature which predetermines it to be used in manipulators, building, earth-moving and agricultural machines. It is mainly due to the fact that a relatively wide assortment of working equipment can be attached to the end of telescopic jib arm. Individual types differ from one another in their structure mainly because they are designed for various operating conditions and different equipment. The individual producers´ team of designers use mostly their own know-how which is a subject of patent protection in many cases. The application of the optimization module, which is part of the majority of high-end CAE software, allows to design the construction of technical parameters for so general utilisation as possible.

From the functional point of view the telescopic jib presents a constructional arrangement of components which are called “guiding” in the technical practice. In fact, it is a system in which the movable part is attached to the stationary part and it moves along geometrically precise and predetermined paths. Its main parts are the outside arm, inside arm and the guiding elements. In addition, it includes also other components which ensure e.g. mutual shift of the arms and working equipment. It is also necessary to consider the effect of the axial rotation mechanism, although it is not often part of the telescopic jib subsystem. The thing is that it affects the design and calculation themselves mainly by its dynamic impacts. On the basis of the above mentioned facts, we can state that the force proportions are necessary to be evaluated from the viewpoint of static load and with the effect of dynamic load. On the one hand, the questions of force proportions can be evaluated within complex loading, but at the same time they can be observed separately, i.e. from the viewpoint of statics or dynamics. The relations concerning particular cases of load are evaluated in two reciprocally perpendicular planes: in the plane of jib stroke (vertical plane) and in the plane of rotating around the vertical axis (horizontal plane).

Within the analysis of loading forces in the vertical plane it is possible to appraise two basic operation modes: when lifting the jib or when backing it to the support plate on which the equipment is placed. In the process of lifting the bearing structure, the jib is loaded by the mass of particular components, by reactions activated in the places of jib locations and by forces of lifting mechanism activity. From the viewpoint of stressing, forces of the greatest impact are those ones arising as a result of external force application on the working equipment which is usually fixed at the end of the extensible arm. If it concerns the using of the telescopic jib when lifting a certain load, then the external loading is mass of the given load. Generally, it is interaction of working equipment and the object of work cycle of the given equipment. In the case of backing the working equipment to the support on which is placed the equipment, mass of the load does not act. The jib is loaded by pressure force arising as an effect of the mechanism acting and its running in the vertical plane. If it concerns mobile working equipment, the analysis of external loading in a simplified case reduced to solving of the classic task of balance of moments. In both cases (lifting or holding down), it is assumed that stabilizing moments equal tiling moments (Fig. 1)

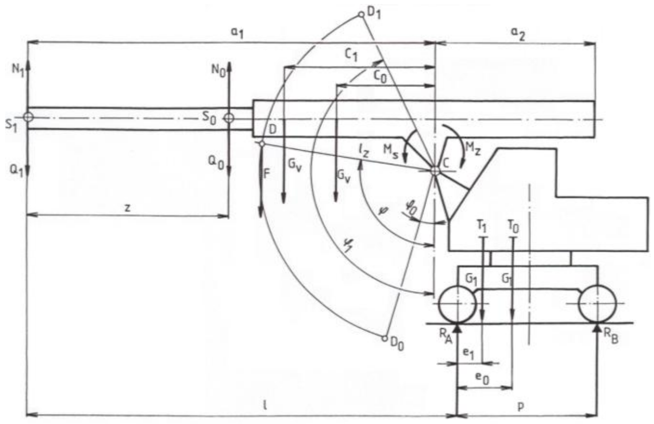

Figure 1. Solution of Moment Balance on the Telescopic Jib

1. fully extended internal arm (point S_1)

$$Q_1.l = G_1.e_1 \qquad (1)$$

2. fully inserted internal arm (point S_0)

$$Q_0.(l - z). = G_1.e_0 \qquad (2)$$

The intensity of external loading force Q_1 at fully extended jib or Q_0 in fully inserted jib in case of the balance of stabilizing moments is then:

$$Q_1 = \frac{e_1}{l} \cdot G_1 \quad \text{or} \quad Q_0 = \frac{e_0}{(l - z)} \cdot G_1 \qquad (3,4)$$

In the horizontal plane, the jib is loaded by the component forces originating while inserting the telescope at eccentric acting on the working equipment at the end of internal arm or at its rotating around the vertical axis, the jib is backed to rigid hold-back.

For dimensioning and the analysis of the state of stress concerning the internal arm, it is necessary to observe the whole operational capacity of the internal arm which is given by length of its extending from the zero position up to the position of maximum extension. For the complete range of extension we have to find out the intensities of reaction in the front and back jockey wheels and the level of bending moment. From the viewpoint of stressing the internal arm, an infavourable position appears to be the maximally extended internal arm in the horizontal position loaded by external force Q (event. force N). Even more infavourable stressing occurs when vertical force acts eccentrically when load of torsion moment joins bending stressing.

Optimization can be defined as a process of achieving such a construction design which is the best of all possible designs with respect to the prescribed aim and the given set of geometric limits to behaviour (state) of the system. From the viewpoint of the problem specification in case of the telescopic jib, it is suitable to set the internal (extensible) arm of the telescopic jib as an object of the optimization analysis. The change of some of its strength parameters (except of height and width of bearing cross-section) has the least response to interlinked constructional parts of the equipment in the system: internal arm → external arm → equipment frame → all the equipment. As the external dimensions of the arm have to be retained, the only possibility to optimise the bearing cross-section is only to modify the thickness of bearing plates. It is also due to the fact that the construction, in principle, does not enable to use additional crossbracing. Actually, inside the arm there is a linear hydraulics for arm extension and hydraulic distribution of control of the working equipment.

2. Method

An example of such optimization process is optimization of the internal telescopic jib arm of the universal working equipment UPS 112 developed by the WUSAM a.s. Zvolen (Fig. 2).

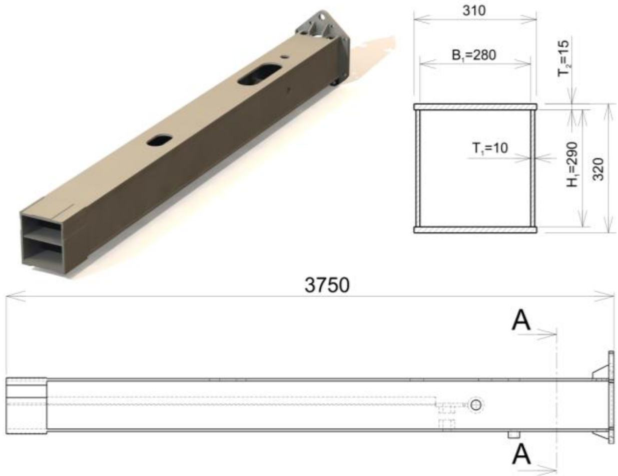

Figure 2. Design and Basic Dimensions of the Telescopic Jib

Optimization calculations have been carried out by the method of finite elements by means of the ANSYS software which is owned by the Department of Mechanics and Mechanical Engineering, the Technical University in Zvolen. The theoretical and practical bases for carrying out these calculations were the results of experimental tests done on the prototype of the UPS-112 equipment. During the test was measured the tilt load of the equipment according to the previous considerations of the main load force. The tilt load has been measured by means of the tensometric dynamometer and the measuring probe of 200 kN. Moreover, the tensometric measurements have been carried out on predetermined parts of the telescopic jib. For this purpose, the equipment for data collection and processing, model DAQ-664 (Fig. 3, produced by Kraus Messtechnik GmbH) and the tensometers models 3/120LY111 and

6/120RY11 (produced by HB Messtechnik, Germany) have been used.

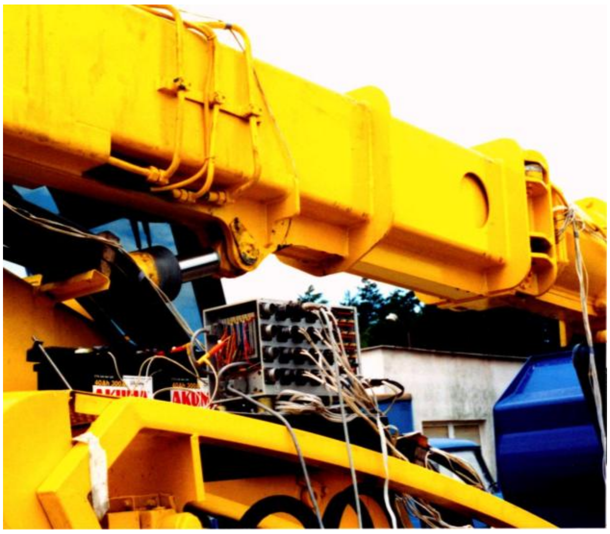

Figure 3. Data Logging and Processing Equipment

The obtained measured values of tilt load have been the input parameters for the analysis of state of stresses and deformations state and also for optimization by means of the FEM. The data obtained by tensometric measuring served to verify correctness of the calculation model, when achieved measured values of stresses and proportional deformations on the prototype were compared to calculated values. The comparison of calculated data and results of tests has been carried out in the two ways.

The former one was to find out stresses and deformations on trajectories which were passing through the places of measurement by application of the command *Path Operation* in the *General Postprocesor* menu.

The latter one was to find out values directly in the particular nodes in hypothetical places of mounted tensometers using the command *Query Results → Subgrid Solution.* Comparing the calculated values and measured values, we have found out that the data are similar and so the closer calculation model is correct.

The basis for creating the calculation model for ANSYS was the 3D model designed in the Creo Parametric software. The transfer of 3D geometry of the model into the ANSYS environment was carried out by the application of the *Import* command which enables a direct download of its geometry in the form of volumes, areas and keypoints. Two calculation models have been created. One was created by means of the type element SOLID95, the other one by means of the type element SHELL63.

SOLID95 is a higher version of the 3D 8-node solid element (SOLID45). It can tolerate irregular shapes without as much loss of accuracy. SOLID95 elements have compatible displacement shapes and are well suited to model curved boundaries. The element is defined by 20 nodes having three degrees of freedom per node: translations in the nodal x, y, and z directions. The element may have any spatial orientation. The element has plasticity, creep, stress stiffening, large deflection, and large strain capabilities [6].

SHELL63 has both bending and membrane capabilities. Both in-plane and normal loads are permitted. The element has six degrees of freedom at each node: translations in the nodal x, y, and z directions and rotations about the nodal x, y, and z axes. Stress stiffening and large deflection capabilities are included. A consistent tangent stiffness matrix option is available for use in large deflection (finite rotation) analyses [6].

Parameters of both meshed calculating models are given in Table 1.

Table 1. Parameters of Meshed Models

	ELEMENTS	NODES	AREAS	LINES
SOLID 95	39 197	77 178	424	882
SHELL 63	13 110	13 301	239	600

Optimising calculations have been made on the calculating model created by means of the element type SHELL63. It was mainly for the reason that calculating model created from the elements of SHELL63 type was less time-consuming in the applied hardware. The decision to use the specific element type was made also because the analysis of the state of stresses and deformations, which had been carried out before optimising calculations on both model types, showed almost no differences in the results.

The calculations have been carried out in 11 different load states of external load. The main task of calculations was to optimise bearing panel thickness of the internal arm.

The first optimising calculation was carried out for the load acting in the axis of symmetry of the arm. Next ten calculations differed from this alternative by the fact that external load force in particular cases gradually worked outside the mentioned axis of symmetry, i.e. it affected the particular arm.

As a final consequence, it caused that, in addition to bending moment, the jib arm is loaded also by torsion moment. The intensity of the moment was being increased, so that the arm of torsion moment has gradually increased from the zero position up to 1 meter. The increase of the arm for particular calculation positions was determined as 0.1 meter. In all cases the external load force equalling to tilt force (28.2 kN) was considered.

3. Results

The result of optimising calculations has been the finding out alternatives of bearing plates thickness. The alternative values are presented in Figure 4.

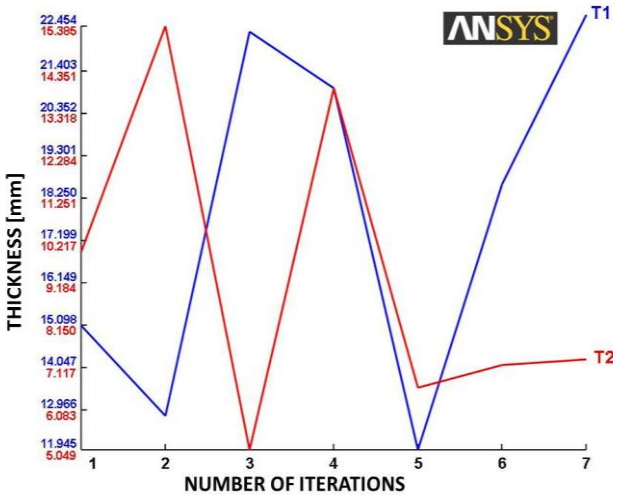

Figure 4. Alternative Thickness of Plates

Due to the extent of the article, there are given only optimization parameters of load force affecting the considered maximum arm of load force. In addition to stated thickness of plates (T1 and T2) in the graph are included also other input optimization parameters (Tab.2. B1 and H1) which have not been considered and evaluated because of the extension of the work.

*Table 2 List of Optimization Sets - Output from the ANSYS (*SET 1 - basic design)*

	H1	B1	T1	T2
*SET 1	290.00	280.00	15.000	10.000
SET 2	296.18	279.14	12.760	15.386
SET 3	296.18	282.36	21.957	5.0499
SET 4	286.73	276.41	20.855	13.732
SET 5	292.38	271.40	11.946	6.6867
SET 6	289.79	289.79	17.633	7.2634
SET 7	297.17	287.37	22.454	7.2354

The basic dimensions and parameters of the objective arm are stated in the Figure 2. The design of steel constructions within the present complexity of machinery cannot be only a matter of designer´s sense and intuition. The application of such unprofessional processes often leads to degradation of the initial intention of the technical solution. Eventually, this implies the two extremes – the construction is either overextended or underextended [1].
The first case means an unreasonable and excessive increase of weight, which is not so disastrous from the viewpoint of overall functionality of the given construction.

The undersizing may bring more after-effects. In this case, such stresses and deformations can appear that cause destruction of some part or several parts of the construction. Thus, the construction cannot meet functions which it was initially designed for [3].

4. Conclusion

The telescopic jib represents a relatively complex bearing steel construction. Although particular construction designs are quite different, their calculation scheme is essentially identical. As it has been already mentioned in the previous chapters, from the viewpoint of calculation it is important to take into consideration more calculation positions of specific jib arms.
Within the positions, it is necessary to analyse specific elements of external load and to find the most unfavourable combination of the arm positions and external load. Such a combination seems to be maximally extended jib at eccentrically acting external load force. With regard to the above mentioned facts we can carry out the analysis of stresses and deformations. However, we do not consider only this specific situation, but each situation where extreme values of stresses and deformations can be assumed.
By application of the FEM in connection with the computer equipment, it is possible to cope fully with the problem of optimization of any steel construction including the telescopic jib. The obtained results can form a general theoretical background for designing the specific types of telescopes because such a publication of the know-how has not been available up to now.

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OBTAINING KINEMATIC GAIT PARAMETERS FROM IMU SENSORS

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Abstract

Modern gait analysis has proven to be very helpful in obtaining vital information in the rehabilitation and medical intervention of gait pathologies. However accurate systems are rarely employed due to their high investment and relatively restricted measurement environment. This paper will propose an alternate method for obtaining kinematic gait parameters using Inertial Measuring Units (IMU). To establish a benchmark of the results, the Vicon optical motion capture (OMC) system records the gait events in unison with the IMU, and the resulting data is compared. The results show that when properly implemented, joint angles and accelerations in the lower limb segments correlate very well, however more inputs are required if we desire a full kinematic analysis.

Keywords:

gait analysis, inertial measuring unit, telemedicine, Kalman filter.

1. Introduction

Currently, the most widely accepted gait analysis methods employ the optical motion capture method (OMC) to measure patient activity in a clinical laboratory. The OMC systems have established themselves as a very effective tool in the diagnostics, intervention, and optimization of gait parameters [1]. The problem with these systems lay in their cost and flexibility. OMC systems employ several expensive cameras to triangulate the position of physical markers in space and the size of the measurement volume typically determines how many cameras we can use. The OMC also requires strict environmental conditions to ensure reliable tracking of the markers. The advent of MEMSIC accelerometers and gyroscopes have allowed us to construct affordable Inertial Measuring Units (IMU) capable of measuring the approximate attitude of the sensors local coordinate system LCS relative to the global coordinate system GCS, through the implementation of a Kalman filter [2]. IMU's can be wireless with on board data logging and can be made to withstand a wide variety of environmental condition, expanding the possibilities for measurement's to occur away from specialized laboratories. Being able to accurately measure gait parameters through such affordable systems would broaden the application of gait analysis and hopefully increase the standard of living for all that would benefit from gait related intervention.

2. Principles of the IMU

An IMU combines accelerometer and gyroscope data through a complimentary filter to obtain a good estimate about the actual state of the system. Accelerometers can accurately measure the orientation of the system provided we have static conditions.

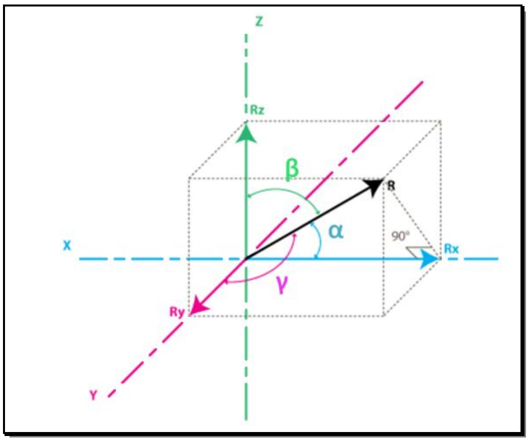

Figure 1. Vector representation of accelerometer in space

Since we know that in nearly static conditions the magnitude of the resultant acceleration must equal 9.81m/s^2 (due to gravity) with an orientation directly downward, we can use basic trigonometric relations to solve for the joint angles. However, in gait analysis we are trying to measure a highly dynamic system, thus measuring attitude with the extremely sensitive accelerometer will yield un-interpretable results. The gyroscopes on the other hand are not as prone to external noise and are very accurate in measuring the angular rate about the sensors principle axes. However, in order to obtain kinematic results, we must integrate the angular rate to obtain joint angles. This integration results in gyro drift, a well-known phenomena with gyro sensors [3], which can be corrected with our accelerometer measurements and a complimentary filter.

3. Obtaining the Attitude from Measurements

In order to obtain an accurate estimate of the sensors orientation, we use a complimentary filter. The Kalman filter has been proven to be most effective in this respect [4] and therefore it is implemented were the state is given by:

$$x_{k-1} = Ax_k + Bu_k + w_k \qquad (1)$$

and the inputs are from the measured accelerometer inclination and inclination obtained from gyroscope integration, while the gyroscope parameters are obtained separately.

4. Apparatus and Method

The IMU consists of a 3-axis analog ±5g accelerometer from analog devices and a dual axis analog ±100deg/s gyroscope from ST microelectronics. Both sensors are mounted orthogonal to each other on a custom chassis. This chassis is mounted on the center of mass (COM) of the patient's lower limb segments, calculated according to [5]. The marker set used for the OMC are mounted similar to the Helen Hayes simplified marker set. The setup can be seen in figure 2.

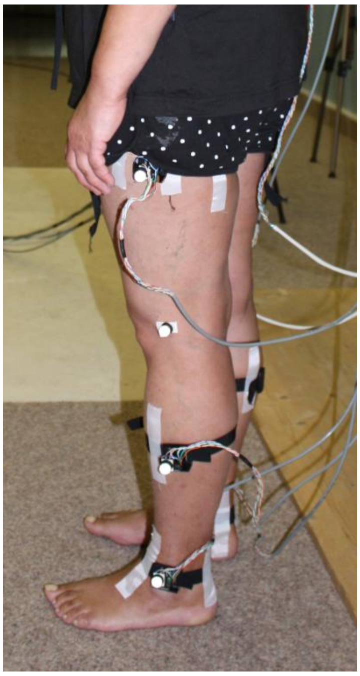

Figure 2. IMU's mounted on patient

The patient is instructed to assume an upright posture while the IMU and OMC system is activated; this allows the IMU time to obtain some initial conditions about the system. The patient than performs several gait cycles and again assumes an upright posture at the end of each measurement. The data collected is processed and exported into the MATLAB environment for further processing.

5. Results

Figures 3, 4, and 5 show the results from the OMC measurements versus the IMU measurements, while the correlation between both methods is found through the Pearson correlation coefficient given by:

$$R = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{n(\sum x^2) - (\sum x)^2}\sqrt{n(\sum y^2) - (\sum y)^2}} \qquad (2)$$

were values closer to 1 represent a higher correlation between each method.

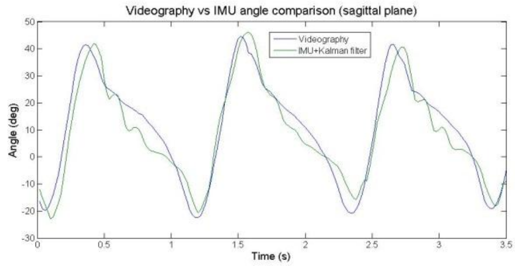

Figure 3. Angle comparison between the OMC and IMU measurements for right shank

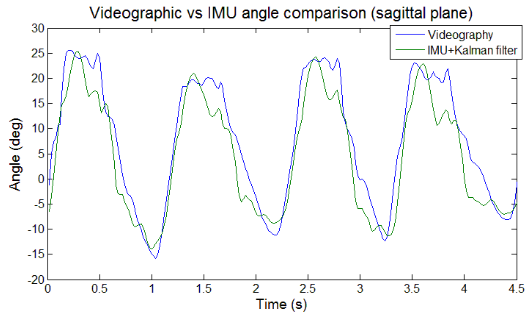

Figure 4. Angle comparison between OMC and IMU measurements of the right thigh

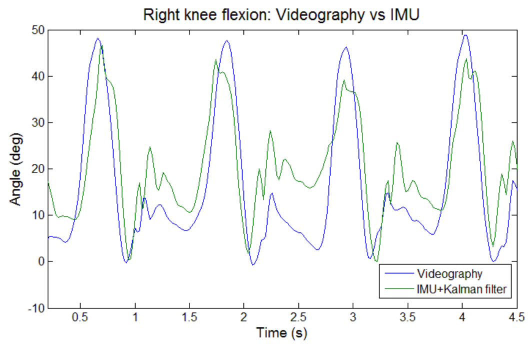

Figure 5. Right knee flexion comparison between OMC and IMU measurements

Table 1.Correlation coefficients between IMU and OMC data, SD – Standard deviation

SEGMENT	Operation	Correlation (*R*)			
		LEFT	*SD(deg)*	Right	*SD(deg)*
Hip	Flexion-extension	0,959	±1.08	0,958	±0.93
	Abduction-adduction	0,594	±4.96	0,603	±5.14
Knee	Flexion-extension	0,883	±6.08	0,939	±5.04
	Varus-valgus	0,408	±0.98	0,587	±1.05
Shank	Sagittal	0,942	±5.64	0,909	±6.38
	Lateral	0,848	±6.45	0,641	±7.19

6. Conclusion

The results show a very good correlation between IMU and OMC results in joint angles in the major planes making IMU's a viable substitute to restricting OMC methods; however more inputs into the Kalman filter are needed in order to obtain complete kinematic information such as vertical and horizontal position (translation). For future works, it is highly recommended that a 9DOF IMU is implemented in order to use heading information to obtain all kinematic assets that a typical OMC is able to record. Finally, according to the results obtained, it can be seen that IMU's have the potential to be implemented into a more affordable gait analysis package.

7. Acknowledgement

A special thanks goes to Mgr. Zdenek Svoboda, PhD and the University of Olomouc, Czech Republic for the use of their VICON OMC system.

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PROPERTIES OF STEEL SHEETS TREATED BY PLASOX PROCESS

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Abstract
Nitrooxidation as a thermo-chemical treatment significantly increases the mechanical properties, corrosion and wear resistance. The nitrooxidation process is possible to provide by several procedures among which belongs also plasma nitrooxidation, commercially known as PLASOX process. In comparison to other nitrooxidation processes, the PLASOX process is capable of creating the compact surface layer of the same thickness, but at lower temperatures and shorter processing time. The paper deals with evaluation of mechanical properties of steel sheets treated by plasma nitrooxidation as well as their microstructural analysis.

Keywords:
surface treatment, PLASOX, microstructural analysis, mechanical properties

1. Introduction

Plasma nitrooxidation belongs to the non-conventional methods of material surface treatment. The RÜBIG Company has created a thermo-chemical treatment process also known as PLASOX consisting of two separate steps. The first step of process represents the surface cleaning (sputtering process) and subsequently plasma nitridation in the environment of ammonia (or mixture with other gases). During this step, the diffusion layer rich in nitrogen is formed. Surface layer after nitridation can be formed by the white layer (called also a compound layer) and the diffusion zone. The white layer presence could be suppressed by subsequent thermal treatment. The second step of nitrooxidation by PLASOX process is oxidation in environment rich in oxygen (vapours of distilled water or in plasma) [1, 2, 3]. By oxidation process, the Fe_2O_3 and Fe_3O_4 oxides are created on the material surface [4]. This way treated materials manifest increased mechanical properties as well as hardness and corrosion resistance [2, 3].

2. Methods

As a base material for thermo-chemical treatment by PLASOX process, low-carbon deep-drawing steel DC 01 was used. PLASOX process was performed on steel sheets with dimensions of 250×200×1 mm. This material is used in automotive industry for its very good formability. The chemical composition of DC 01 steel is referred in Table 1.

Table 1 Chemical composition of steel DC 01 base material

EN Identi-fication	C [max. %]	Mn [max. %]	P [max. %]	S [max. %]	Si [max. %]	Al [min. %]
DC 01	0,12	0,60	0,045	0,045	0,1	-

Thermo-chemical treatment by PLASOX process was realised in RÜBIG Company, Austria. Specimens were tested by tensile strength test, Erichsen cupping test and microhardness measurement.

3. Results

For microstructural analysis of steel sheets treated by PLASOX process the scanning electron microscope JEOL 7600-F was used. The structure of material consists of three different layers, which are documented in Figure 1. On the top of the material, very thin oxide layer with thickness of 0.7 μm was observed. White layer (most known as the compound layer), which was observed under the oxide layer, consists of ε - phase and γ´- phase [3]. White layer was composed of two parts. Top part of the white layer was very porous and its thickness was approximately 1.7 μm. The bottom part was continuous, porous free and its thickness was approximately 4.5 μm.

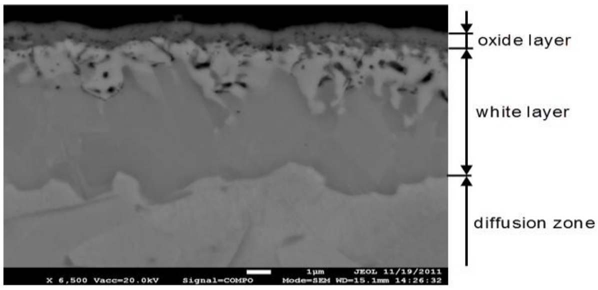

Figure 1 Surface layer of the material after PLASOX process

Below the white layer was a diffusion zone consisting of γ’-nitrides needles in ferritic matrix (Figure 2).

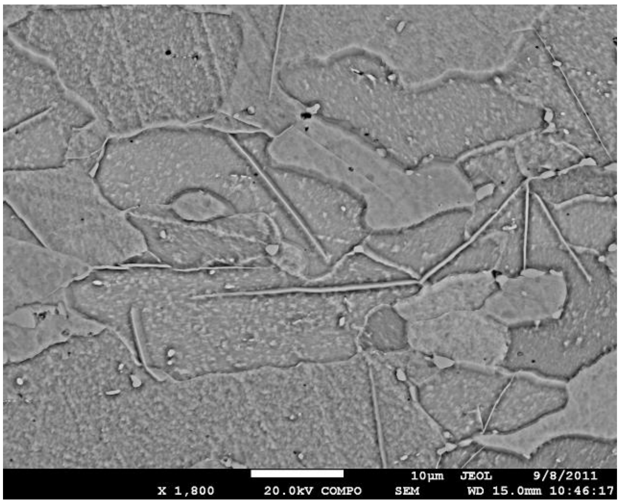

Figure 2 Needles of nitrides in diffusion zone [5]

Microhardness measurements

The microhardness measurement according to Vickers was performed on Buehler IndentaMet 110 series equipment. The microhardness measurement results, measured across the material thickness, are documented in Figure 3. The first measurement was performed in the depth of 15 µm from the surface and the distance between two indents was approximately 80 µm. Microhardness of surface layer after PLASOX process was approximately 250 HV 0.1, representing the 150 % increase in comparison to the DC 01 base material.

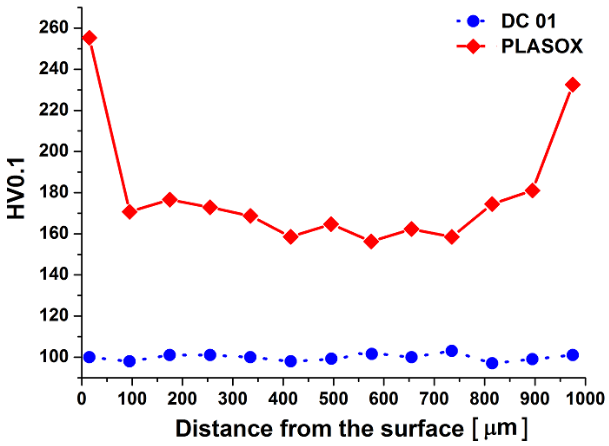

Figure 3 Microhardness comparison of treated and non-treated material

Static tensile strength tests

Static tensile strength tests were performed to determine the mechanical properties of steel sheets before and after the PLASOX process. The tests were performed on three specimens with the dimensions of 200×20×1 mm. The obtained values of tensile strengths and yield strengths are referred in Table 2. Mechanical properties of steel sheets after the PLASOX process significantly increased in comparison to the base material. Yield strength of specimens treated by PLASOX process increased by approximately 87% and the tensile strength increased by 77% in comparison to base material [5].

Table 2 Mechanical properties of steel sheets before and after the PLASOX process

Treatment	Yield strength [MPa]	Tensile strength [MPa]
Non-treated	200	282
Treated by PLASOX	375	500

Erichsen cupping test

The negative influence on deep-drawability of the PLASOX process was investigated due to the significant increase of the mechanical properties. The depth of the indents during the Erichsen cupping test (table 3) was measured as a reference value at the moment of the fracture appearance.

Table 3 Erichsen cupping test results

Treatment	Depth of the indent [mm]
Non-treated	10.73
Treated by PLASOX	8.75

After thermo-chemical treatment, the depth of the indents decreased by 18.8% in comparison to the non-treated material. PLASOX process negatively influenced the deep drawability. This decrease of deep drawability due to the nitrides present in the whole volume and not only near the surface layer of the material. Steel sheets after Erichsen cupping test are documented in Figure 4.

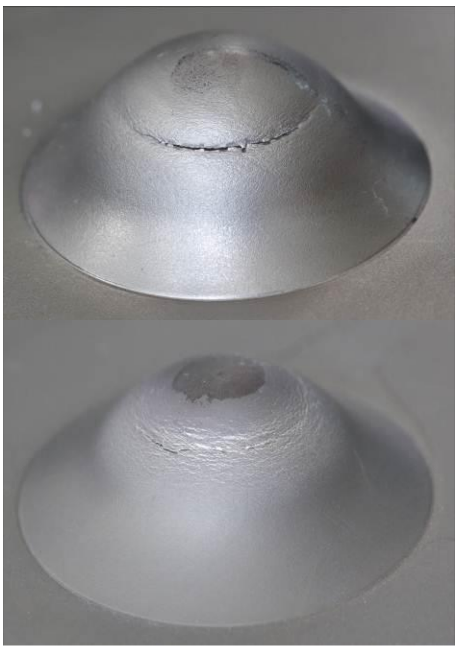

Figure 4 Erichsen cupping test: DC 01 (top) and PLASOX process (bottom)

4. Conclusion

It is obvious that surface treating by PLASOX process represents a new generation of thermo-chemical treatment with high level of reproducibility of surface level properties. This is achievable thanks to process computer control [4]. The research results together with the literature retrieval point to significant improvement of mechanical properties and corrosion resistance, but on the other hand there is remarkable drop of ductility and deep drawability according to Erichsen. These facts should be taken into account during machine equipment design based on materials treated by nitrooxidation process. That is why it will be necessary to watch the parameters of nitrooxidation process and their effect on final material properties in further research.

5. Acknowledgement

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EFFECT OF BASALT POWDER ON THE RHEOLOGY OF FRESH CONCRETE AND HARDENED CONCRETE PROPERTIES

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Abstract
The paper deals with the influence of basalt powder on rheological properties of fresh concrete and strength properties of hardened concrete. In combination with new generation superplasticizer it is possible to a make selfcompacting concrete that can flow and be compacted without additional energy. The results obtained show that the basaltic powder has a positive effect on the consistency of fresh cement composites and increase the strength of the hardened composite.

Keywords:
self compacting concrete, polycarboxylate, basalt powder, superplasticizer, rheology, compressive strength, flexural strength

1. Introduction

Self-compacting concrete (SCC) was first developed in Japan in the late 80 the last century as a material that can flow through the dense reinforcement, without further consolidation and can be compacted in the form only by its own weight.

Mineral additives are very important components of SCC. Global study shows the advantages of their using in concrete production. These materials improve workability and other rheological properties of fresh concrete as well as the properties of hardened concrete. The use of mineral additives leads usually to reductions the quantity of cement. Considering the fact that cement is the most expensive component in concrete, the reduction of cement content has also an economic impact. It is also known that some mineral additives reduce thermally-induced cracking of concrete due to lower total heat of hydration and improve the workability and long-term properties of concrete. From the point of view of SCC it is very important, that the mineral additives can reduce or prevent the segregation and bleeding of the fresh liquid concrete. Use of mineral admixtures in SCC can also lead to the reduction of the quantity of the superplasticizer needed for the reaching the desired consistency [1, 2, 5].

Commonly used mineral admixtures are usually byproducts of industrial production, or waste materials such as limestone powder, silica fume and blast furnace slag etc. Basalt powder is a by-product of stone crushing in basalt quarries. High amounts of gathered powders is a big problem from the point of view of the liquidation, environmental pollution and health risks. The use of mineral dusts as admixtures in concrete can contribute to solving these problems. This paper presents the results of a study of the effect of basalt powder, on the properties of fresh and hardened cement composites.

2. Materials and method

The effect of basalt powder and superplasticizer on properties of cement mortars was studied on cement mortars prepared from Portland cement CEM I 42,5 R (producer CEMMAC, a.s. from Horné Srnie). Basic properties of the cement are shown in Tables 1 and 2.

Table 1. Physical properties of cement

Standard consistency		29,6 %
Initial setting		150 min.
End of setting		190 min.
Soundness		5,0 mm
Compressive strength after 2 days		30,0 MPa
Compressive strength after 28 days		53,6 MPa
Fineness	residue on sieve 0,2 mm	0,0 %
	residue on sieve 0,09 mm	0,3 %
	residue on sieve 0,063 mm	0,8 %

Table 2. Composition of cement

Chemical composition		Mineralogical composition	
CaO	62,88 %	Alite	56,50 %
SiO_2	20,50 %	Belite	13,71 %
Al_2O_3	5,76 %	C_3A Total	10,38 %
Fe_2O_3	2,72 %	C_3A Cubic	2,62 %
MgO	1,32 %	C_3A Ortho	7,76 %
Na_2O	0,27 %	Ferrite	8,52 %
K_2O	1,14 %	Anhydrite	3,72 %
SO_3	2,92 %	SO_3	3,56 %
MnO	0,055 %	MgO	2,61 %
TiO_2	0,155 %	Portlandit	1,80 %
P_2O_5	0,146 %	Hemihydrat	1,70 %
Cl	0,150 %	Periclase	1,26 %

For the production of cement mortar was used natural river aggregates (location Okoč), from sediments of river Malý Dunaj, composed of three fractions 0/1 0/4 and 2/4. Mixing ratio was as follows: 0/1 = 15%, 0/4 = 55%, 2/4 = 30%. Granularities of the fractions and optimal sieving curve are illustrated in Figure 1. Mineralogical composition of the aggregates is shown in Table 3.

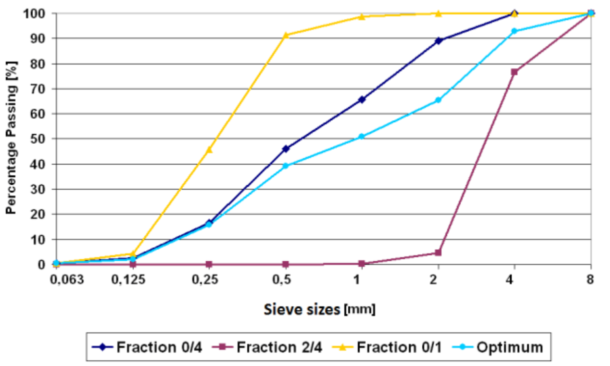

Figure 1. Sieving curves of aggregate used

Table 3. Mineralogical composition of aggregates

Quartz	64,2 %
Granit	5,9 %
Limestone	12,2 %
Sandstone	5,6 %
Quartizite	4,9 %
Vulcanite + met.	7,2 %

For the production of cement mortar was used superplasticizer (SP) based on polycarboxylate Berament HT 5221. Basic properties of the admixture are shown in Table 4.

As an additive in cement mortar was used basalt powder (BP) from a quarry near the village Sološnica, from site of the Small Carpathians. Its chemical composition and fineness are shown in Table 5.

Table 4. Physical properties of superplasticizer Berament HT 5221

Appearance	Homogeneous light brown solution
Density	1,063 $g.ml^{-1}$
Amount of solids	28,1 %
pH at 20 °C	4,51

Table 5. Chemical composition and fineness of basalt powder

SiO_2	44,59 %	Cl	0,02 %
Al_2O_3	15,05 %	Na_2O	4,11 %
CaO	10,89 %	MgO	4,31 %
Fe_2O_3	8,87 %	K_2O	1,39 %
MnO	0,26 %	TiO_2	1,03 %
P_2O_5	0,6 %	CO_2	8,84 %
SO_3	0,02 %		
Residues on sieve			
0,063 mm		3,45 %	
0,09 mm		1,55 %	
0,2 mm		0,30%	

The composition of the reference mortar without chemical and mineralogical admixtures is based on a modified standard mortar according to EN 196-1 [3]. It contained 450 g of cement, 1350 g of aggregate 225 g of water (V/C = 0.45). This reference mortar was further modified by superplasticizer and basalt powder (BP). The doses of superplasticirer were 0.5, 0.75, 1.0, 1.25 and 1.5 % by weight of cement. BP was dosed in amount 10, 20 and 30 % as a partial replacement of cement.

In all mixtures was reduced amount of mixing water with the water contained in plasticizers to keep to the water-cement ratio at 0.45.

Cement mortars were mixed in a standard laboratory mixer according to EN 196-1 [3]. Immediately after mixing the consistency of fresh mortar was determined by using the Haegermann flow table (without use of lifting and dropping of flow table plate).

Cylindrical samples with diameter and height of 30 mm were prepared from the cement mortar for testing the compressive strength. For flexural strength and shrinkage testing the prisms with size of 40 x 40 x 160 mm were prepared. Prisms for measuring of shrinkage were at the ends fitted with glass contacts.

Cement mortars in molds were compacted adequately to their consistency. Test samples were cured for 24 h in a humid environment and further in water.

Compressive strength tests were determined in a laboratory using compression testing machine. Flexural strength was determined by three-point method.

Shrinkage of mortars was determined by shrinkage measuring device by measuring the differences in length between mortars samples and metal etalon.

3. Results and discussion

Results of tests that were focused on the rheological properties of fresh cement mortars are shown in Figures 3 to 5.

The initial consistency of fresh mortar (Figure 3) was positively affected by the addition of SP and BP. With increasing dose of superplasticizer the consistency of mortar without basalt powder gradually improved up to dose 1.25 %. At the dose 1.5 % there was observed mild segregation of mortar and separation of mixing water and also a reduced flow diameter of mortar. Mortars modified by superplasticizer in a dose of 0.75 % have begun to show signs of thixotropy and selfcompactability. These tendencies increased with increasing dose of SP.

Partial replacement of cement by BP in the cement mortar without SP has not improved the consistency (flow diameter) but at the small replacement (10 %) the mortar had better workability (preparation of samples was easier). Increase in BP content (20 and 30 %) led to a slight deterioration of workability.

The replacement of cement by BP in plasticized mortars led to a significant improvement in workability of fresh mortars. The flow diameter increased with increasing of proportion of BP to dose of supeplasticizer 0.75 %. At higher amount of plasticizer the flow diameter slightly decreased with increasing of BP portion, but it was still higher than in the case of cement mortars without BP (at the same dose of superplasticizer). Decrease of flow diameter can be explained by segregation and bleeding of mortars, which occurred at higher dose of superplasticizer and BP (Figure 3). During the test of consistency the mortars with higher tendency to segregation formed a thicker layer in the center of the circle (due to selfcompaction) and released water and fine particles were deployed around the perimeter. Therefore the flow diameter of these mortars was smaller than that of more homogenous mortars, despite the fact that these mortars were more fluid.

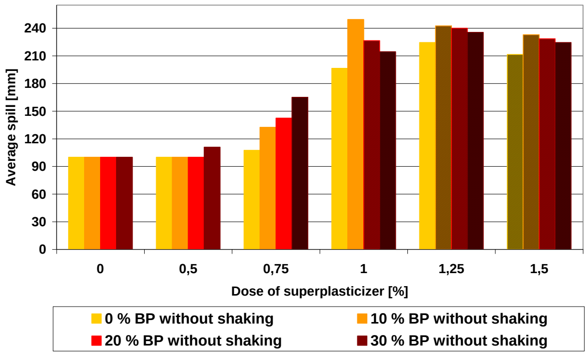

Figure 3. Initial flow diameter of cement mortars (hatched bars represent mortars where segregation has occurred)

Based on these results we can conclude that the basalt powder had additional plasticizing properties, greatly improving the consistency of the mortar, its cohesion and selfcompaction (at optimum dose). Figure 4 documents the change in consistency of plasticized mortar with BP tested without dropping. Consistency of cement mortars continually decreased with time (Fig 4.). 10% dose of BP did not reduce setting time of mortar significantly. Higher doses of BP have slightly shortened the setting time. Segregation of mortar resulted in a worsening of consistency at higher doses of BP and also caused a more rapid loss of workability.

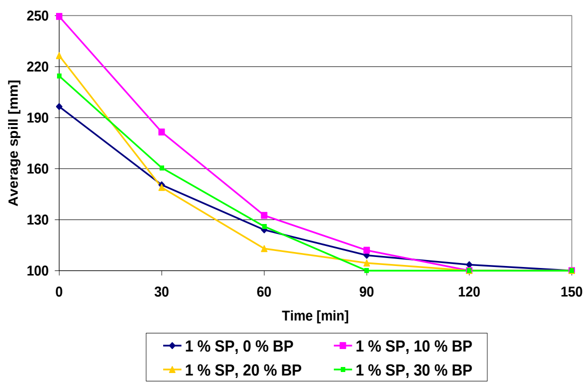

Figure 4. Workability loss of cement mortars

One day and 28-day strength of mortars are given in Figure 5 and 6.

The replacement of cement by basalt powder led to decreasing of compressive strength of mortars. The loss of strength increased with share of BP. A significant decrease was shown in one-day strength while the decrease of 28-days strength was relatively slight. The loss of compressive strength is in conformity with expectation because the increasing proportion of BP in mortars means lower content of cement.

Smaller differences in strength after 28 days of hardening as is shown in Fig. 6 mean that mineral admixture used contributes to the development of strength. Based on these results it can be assumed that the BP used is not completely inert material. Basalt powder containing 44.59 % SiO_2 may have mild pozzolanic properties and thereby increase the long-term strength of mortars. A similar trend has also been published by Uysal Yilmaz and Sumer [1, 2].

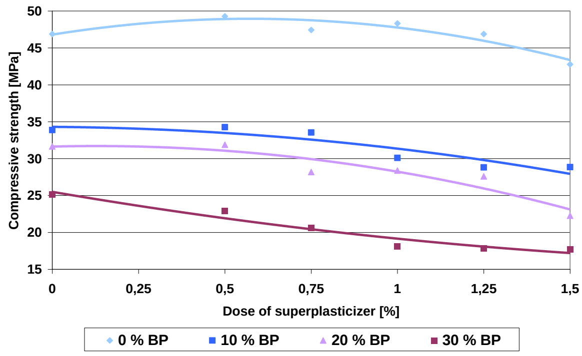

Figure 5. 1– day compressive strength

The effect of various dosage of superplasticizer on the mortar strength was not very strong.

Compressive strength of mortars without BP slightly increased with increasing dose of SP up to a dose of 1% and then began to decrease.

With the increase of the proportion of BP and dose of SP the strength of mortars decreased. This tendency was stronger at 1-day compressive strength. These results were obtained at constant water to cement ratio.

Decrease in strength of mortars with high doses of chemical and mineralogical admixtures is significantly affected by the segregation of the mortars, that leads to their non-homogenous structure and consequently to a reduction in strength.

The results of measurements of flexural strength are shown in Figure 7. Flexural strength tendencies are practically the same as those for compressive strength.

The results of the shrinkage of cement mortars are given in Figures 8 - 9.

Figure 8 shows the results of shrinkage tests performed on plasticized mortars. The greatest shrinkage after 56 days was found on mortar without superplasticizer. The shrinkage decreased

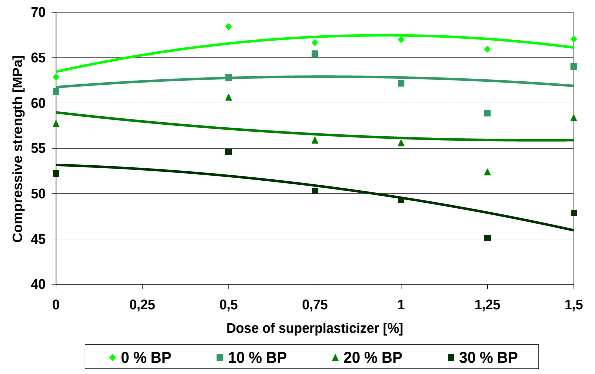

Figure 6. 28 – days compressive strength

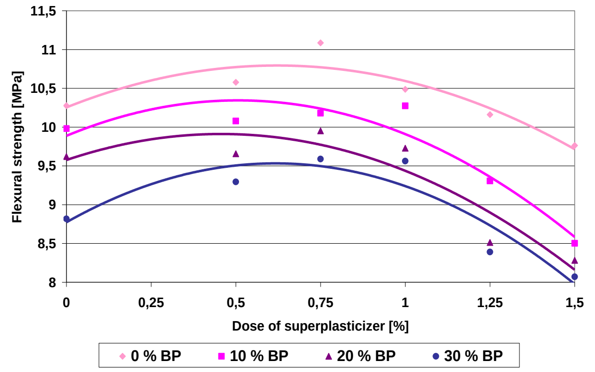

Figure 7. 28-days flexural strength

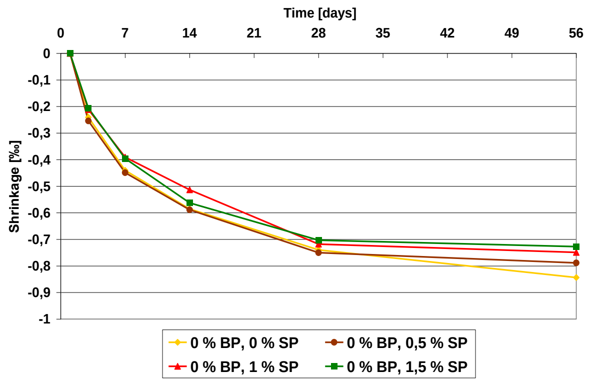

Figure 8. Shrinkage of cement mortars without basalt powder

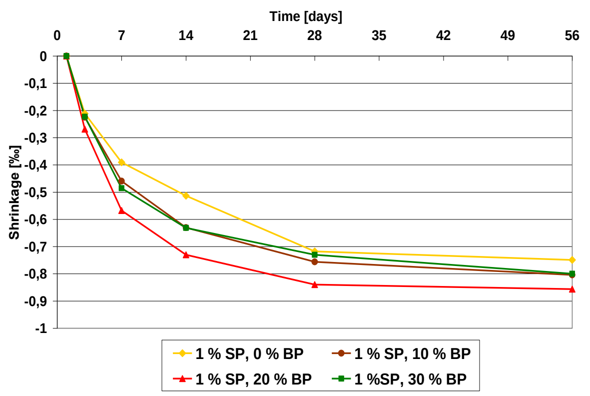

Figure 9. Shrinkage of cement mortars at the dose of superplasticizer 1 %

with gradually increasing the dose of superplasticizer used.

Replacement of part of cement by basalt powder led to an increase in shrinkage. At the mortars without superplasticizer the shrinkage slightly increases with the BP content. A similar tendency was observed also in the mortars with dose of superplasticizer 1% (Fig. 9) with the exception of the mortar with BP content 30 %. Shrinkage of this mortar was smaller than others with lower proportion of BP. This can be explained by the strong segregation of the mortar resulting probably in a smaller proportion of hardened cement paste in the mortar.

8. Conclusion

The obtained results confirmed high effectiveness of used polycarboxylate superplasticizer. Use of this superplasticizer at dose equal or higher that 1 % by weight of cement the mortars obtained selfcompacting properties.

Replacement of part of cement by basalt powder in plasticized mortars resulted in significant improvement of their consistency.

At higher doses of the superplasticizer and the mineral additives the segregation of cement mortars occurred.

The results demonstrate the positive effect of the superplasticizer used and basalt powder on the strength of hardened mortars. The basalt powder does not seem to be completely inert material, but it shows to some extent the pozolanic properties.

Replacement of cement by basalt powder led to a slight increase in shrinkage of cement mortars.

Based on the results we can assume that the basalt powder can be used in production of concrete to improve its properties. Use of this material also reduces the environmental impacts.

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MODEL OF THE TOOL WEAR CONDITION CLASSIFICATION SYSTEM IN TURNING

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Abstract
This paper deals with defining a model for the tool wear classification system with a special emphasis on the module for gathering and processing vibration acceleration signal by applying discrete wavelet transformations (DWT) in signal decomposition. The paper presents a model of the developed fuzzy system for tool wear classification. The system comprises of three subsystems, those being: subsystem for data acquisition and processing, subsystem for tool wear classification, and subsystem for decision-making. The selected method for feature separation is presented within the subsystem for data classification and processing. The selected model for a fuzzy classificator is shown within data classification and clustering, as well as the classification evaluation in experimental laboratory conditions. The applied model has been tested for longitudinal and transversal machining operations.

Keywords:
Tool wear, signal processing, vibrations

1. Introduction

In a completely automated production, timely detection of cutting tool fracture and wear degree is marked as an essential step towards the improvement of productivity and economy in contemporary machining. Developing monitoring systems that would work in real time is a main direction in supervising tool condition and machining process in contemporary automated production. Quality information on tool wear degree in real time presents a necessary prerequisite for tool stability identification. More intensive researches linked to the development of the “intelligent” systems for tool monitoring in the cutting process were introduced in 1990s with the application of multisensor approach, i.e. wear classifiers based on artificial intelligence algorithms [1]. The initial research in this area presented a hypothesis that the application of these methods should result in industrially applied solutions for tool wear monitoring in turning. Scheffer and Heyns [2] emphasise that the majority of systems utilize forces, acoustic emission and vibrations, or the combination of these signals. The confirmation of this fact is explicitly stated by Dutta et al. [3], as well as Balazinski et al. [4]. Indirect methods for tool wear monitoring and the techniques for sensor signal acquisition and processing present the main research directions in most active experimental researches, and they perform it by utilizing signals of cutting forces, vibrations and acoustic emissions. In addition, in order to determine tool wear condition, direct visual methods have been employed as well. However, these methods have application limitations in practical conditions in real time. Wear monitoring has the task of protecting the machining process from unpredicted deviations through simple managing steps. Wear monitoring implies a strategy that, based on managing input values into the machining system, enables rapid reaction to the appearing deviations during the process.

Tool wear condition is usually defined as a geometric alteration. Direct monitoring methods, like optical methods utilized for direct measuring of tool’s geometric parameters, have been developed by [5]. Indirect methods for tool wear monitoring are used to perform the correlation degree monitoring between sensor signal and the accompanying occurrence. This approach has the advantage of being less complicated in the sense of appropriateness for practical application. In contemporary machine tools, sensors can be installed in various places, like multi-positional tool support, spindle or some other place on the machine. Furthermore, monitoring the cutting dynamics can provide the insight into the tool wear condition, which is especially indicated in tool entry into and exit out of the process.

In order to research tool wear and machining processes, as well as their influence on the mechanical system of tool machine, various sensors of a wide range of reliability are utilized today. In laboratory research there is a number of realized diverse technical solutions with a various numbers and types of sensors. Sensors for force monitoring are one of the most applied signals in laboratory research and practical application for monitoring the processes of turning and milling. The alteration in cutting forces is directly reflected onto the machine precision and machining quality. Force control can directly influence the improvement of machining quality and the durability of tool stability. Vibration measurements are performed utilizing accelerometers, which are utilized for measuring vibration frequencies and amplitude within the structure of the machine, main spindle, tool and workpiece. The alterations during the machining process can be observed in the alteration of vibration structure, based on which the correlation with the quality of the processed surface and tool stability [6] can be established. Acoustic emission signal is based on several diverse phenomena. There are two types of signals: continuous and transient. Continual signal type appears with plastic deformation in plastic material, while the broken signal appears at the beginning of the formation of initial crack or the formation of fractured chip.

2. Methods and techniques in feature extraction

Input sensor signals and data for the system depend on processing methods and time-frequency signal decomposition. The utilization of the *Short-Time Fourier Transform* (STFT) in combination with wavelet transformations provides highly satisfactory results in their performances in relation to other time-frequency methods [1, 7]. The application of wavelet transformations in processing and analyzing signals gathered on the machine can be successfully employed to analyze diverse dynamic non-stationary signals of mechanic systems as well, proving the accomplishment of this method in feature extraction. It has been observed that time-frequency methods are very satisfactory for feature extraction that would otherwise, on applying some other methods, remain unidentified. The area demanding additional research activity is the integration of machine tool dynamics and the correlation between cutting process and tool monitoring system. Little has been performed to exploit these pieces of information in tool wear monitoring systems. There is a set of methods that could be utilized for generating machine tool dynamic models for the purpose of the integration with tool monitoring systems. The usage of mathematical models provides a potential to expand the comprehensiveness of tool wear monitoring systems considering dynamic characteristics of machine tools.

Wavelet transformation is the most utilized and the most important method for analyzing signals in time-frequency area. It actually provides the possibility of signal analysis on a local level, which is particularly significant with processing non-stationary signals. Transformation procedure is based on comparing wavelet functions of certain width (frequency) defined by a scanning parameter (s) with signal elements of equal width in a determined time interval (*t-kτ*). The scale should be inversely defined considering signal frequency:

$$\gamma(\tau,s)\frac{1}{\sqrt{|s|}}\int_{-\infty}^{\infty}x(t)\varphi^{*}\left(\frac{t-\tau}{s}\right)dt \qquad (1)$$

where τ is translation parameter, *s* is scale parameter, *x(t)* is signal being transformed, γ is frequency composition of the signal *x(t)* in the determined time interval kτ and with the scale *s*, and *φ** is scaled and translated projection of the original wavelet *φ(t)*. When the *s* original function of the determined scale is utilized to perform the total signal analysis, the procedure is repeated for other scale value, i.e. time interval. If the signal contains a spectral component responding to momentary scale value, the multiplication of the wavelet function and the signal at the place where the component exists is a relatively high number.

Parallel to the development of a cutting tool wear monitoring model, analyses have also been performed of the features of various types and shapes of wear identification parameters in relation to wear degree evaluation quality. It can be stated that, with low frequency signals (force, motor power), the most present are parameters from time domain, and then from frequency domain, as well as statistic parameters. With high frequency parameters, like acoustic emission or vibrations, the first place is taken by parameters from frequency domain, followed by statistic parameters and parameters from time domain. The lowest presence is of parameters from time-frequency domain. The analysis of the available papers illustrates that the parameter selection process in most cases has a goal to select optimal parameter number, and only then to select the most suitable parameter set in respect to recognizing the influence of each parameter individually onto the degree of tool wear. It can be observed that the problem of analyzing and selecting wear parameters has been treated in several manners in literature. Mostly, there is no explanation linked to their selection. The analysis of a number of papers that separate a set of parameters which had been analyzed and chosen based on the degree of correlation with the wear process refers that the most applied methods are: SFS (*Sequential Forward Search*), SBS (*Sequential Backward Search*), PCA (*Principal Component Analyzes*) and their mutual correlation. A number of methods utilize so-called sequential parameter selection which implies their mutual independence in tool wear evaluation, the other segment being the selection of parameter combination. Generally stating, in contrast to the combined approach, with individual parameter selection the number of parameters has less influence on model complexity and the increase of demands for supplementary analyses. Conversely, certain situations demonstrate that mutual parameter influence can result in higher correlation degree with wear dynamics than in the case of individual approaches.

3. Model for tool wear monitoring system

Previous experiences in developing diverse system models based on the application of artificial intelligence, presented in literature, have served as a fine initial basis for developing a new model. The analysis of mentioned models provided an insight into the advantages and drawbacks of certain models, which was taken into account when developing a new model. Considering the previously stated facts from the introduction, the following demands have been set prior to establishing a new laboratory system:

- The use of sensors for measuring vibration acceleration in order to provide better detection of dynamic characteristics of cutting process and their implementation into the monitoring system.
- The use of new algorithms for the application of artificial intelligence in the field of tool wear monitoring, based on the employment of a priori knowledge on tool wear condition.
- The detection of satisfactory manner to select vectors with input characteristics utilizing transformations in time-frequency domain.

The consideration and application of these demands lead to the development of a tool wear monitoring system model presented in Figure 1.

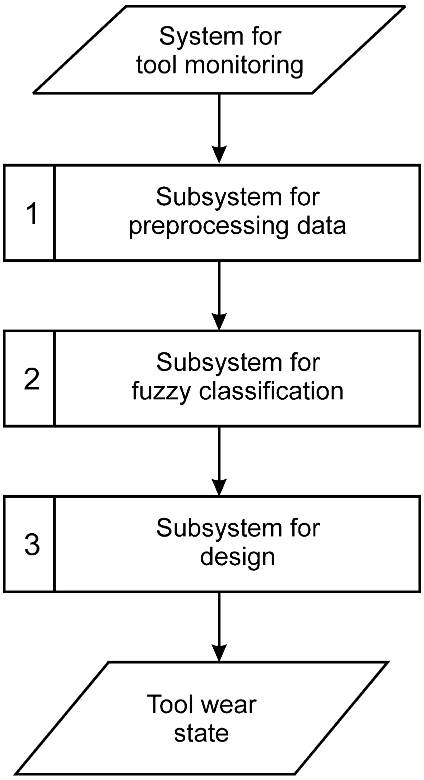

Fig.1 model of a tool wear monitoring system

System model can basically be observed through three segments united into one entity. The developed segments (subsystems) of the laboratory system for tool monitoring are as follows:

- Subsystem for signal acquisition and processing,
- Subsystem for fuzzy classification,
- Subsystem for decision-making.

Sensor segment of the module for data acquisition and processing comprises of the accelerator for measuring vibration acceleration installed on the tool handle. Subsystem for data acquisition and processing also contains A/D card NI USB 6281 18bit, 625 kS/s, which receives analogue information from the existing sensor, converts them into digital information, and transmits them into the measuring database in the computer. To manage the card, Matlab software system has been employed. The system enables defining speed of data sampling and other necessary functions for the operation of subsystem for acquisition.

The structure of the subsystem for acquisition and processing can be observed through three phases presented in Fig. 2. In the first phase of *data acquisition*, gathering data from sensors is performed together with the selection of a filtration band. In the concrete situation, low-pass Butterworth filter is applied to perform the filtration of various noise types that define measuring signal.

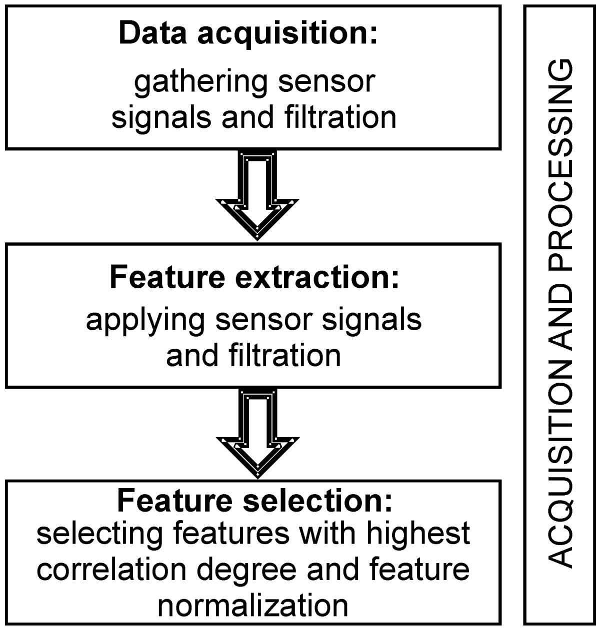

Fig.2 Subsystem for acquisition and processing

The second phase is ***feature extraction***. The main goal of feature extraction is to significantly decrease the dimensions of “raw” data received from sensors in time and frequency domains, and simultaneously to maintain relevant information on tool condition in extracted features. The matrix of the spectrogram S of signal $s(n)$ consists of columns acquired as the square of the Discrete Fournier transform (DFT) module of “windowed signal” *s(n)*. Spectrogram parameters are shape and length, as well as the degree of overlapping/alpha between two adjacent window functions *w(n)*. By averaging all the columns in the matrix of the spectrogram *S* the estimation of the signal force spectrum is achieved. Since, due to previous analyses, it has been established that the signal force spectrum is not satisfactorily discriminative feature, spectrogram normalization has been performed in such a manner that the estimation of the signal force spectrum is subtracted from each column of the matrix *S*. Afterwards, the following steps have been performed:

- Separation of certain spectrogram range (~10 kHz to ~45 kHz),
- Treatment of the spectrogram as a two-dimensional signal,
- Application of selected filters from LM filter bank,
- Calculation of appropriate statistic parameters from the values acquired by filtration,
- Formation of features that are to be utilized for classification in the next subsystem.

In order to improve the accuracy and the efficiency of the applied classification algorithm and to decrease the demands for computer performances of a tool wear monitoring system, the selection of optimal number of significant features in the final model has been carefully elaborated and defined in the third segment of the module for acquisition and processing.

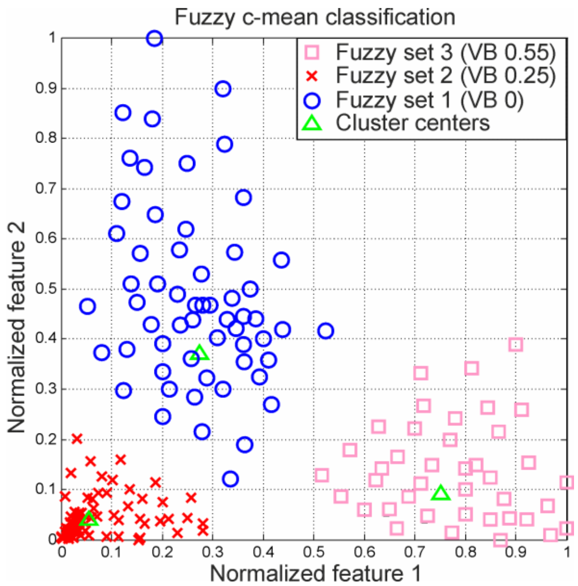

Fig. 3 Cluster centre distribution for the combination of features variance and kurtosis

Fig. 3 presents the survey of the classification process results after employing fuzzy c-mean (FCM) algorithm. Presented results refer to the fact that the application of such classificator model can achieve the satisfactory accuracy in tool wear estimation.

4. Conclusion

The main conclusion that can be observed is the fact that the presented classification model type demonstrates a highly distinctive demand for qualitative larger number of input information vectors. Furthermore, the necessary prerequisite for appropriate classificator performance is the application of a larger number of process parameter combinations in the procedure of initiating and stabilizing model structure.

5. Acknowledgement

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THE USE OF SECONDARY RAW MATERIAL BASED ON ZEOLITES IN THE CERAMIC INDUSTRY

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Abstract
Natural zeolite is widely used in agriculture, construction, environmental protection, and various industries. In this article, we focus on the use of zeolite waste in brick industry. The results obtained show that the zeolite wastes can be used as opening material in reducing of drying sensitivity. In some cases, it is possible their application for the increase of frost resistance.

Keywords:
zeolite, waste, brick clay, pore structure

1. Introduction

In this article, we would like to focus on the use of zeolite dust in the brick industry. We first met with its application at the Waste Summit 2007 conference [1]. In particular, the zeolite dust was shown to be very effective in eliminating of the reduction core in roofing tiles. At the same time, it was discovered that its presence in the brick raw material after firing caused an increase in volume and median of pore radius. This knowledge could be also used to increase frost resistance, especially if there is a significant increase in the median value of pore radius as described in the article [2].
It is important to mention the fact that the different types of zeolite waste can be applied not only in the brick industry but also in ceramics [3,4,5]. In ceramics, the application of waste with heavy metals has been recently shown to have positive results [10]. Because of this fact, our attention was directed to the use of used modified zeolite product Klinopur-Mn, which might be applied in contact filtration of groundwater to remove manganese and iron.
As previously stated [6,7], the presence of manganese compounds in water causes technology problems, disturbances in water supply networks, and deterioration of water quality in terms of its taste and aesthetic qualities. Because the presence of manganese without iron in groundwater is rare, technology process of removing manganese from water is closely associated with the removal of iron.

2. Characteristics of raw materials and ingredients

2.1. Brick clay

The brick clay from the site Nitrianske Pravno was used as the starting material. It is composed of quaternary sediments, which are represented by layers of clay and clay- dust soil of aeolian origin. Its granulometric composition is shown in Figure 1.

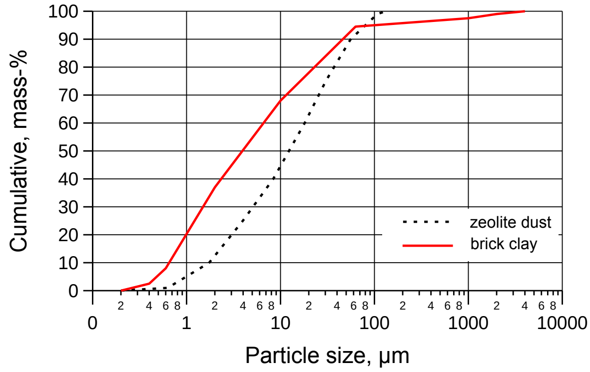

Figure 1. Grain size composition of brick clay and zeolite dust

From the mineralogical point of view, it is a montmorillonitic - illitic and almost non-carbonate material. This is confirmed by the chemical composition of which is shown in the Table 1.

Zeolite dust (Z) was supplied by Zeocem, a. s. Bystré. In terms of granulometry, this is a very fine product of variable composition, with 75 to 85% of grains smaller than 0,05 mm and only 1% of grains bigger than 0,2 mm.

It is a surface-activated zeolite by a layer of MnO2 from Nižný Hrabovec. After exhaustion of its oxidative capacity, it was recovered by KMnO4 solution. For our tracking study, the Klinopur - Mn was used after multiple applications of the contact filtration of ground water, see Figure 2b. This type of applied Klinopur - Mn had a reddish-brown colour (this is called ZNF) and its grain size was characterized as monofraction (0,5 to 1,0 mm) at the 97,9% volume. This Klinopur - Mn was also prepared by grinding in a ball mill (this is called ZPF) so that 97,5% of the grains was smaller than 0,045 mm (Figure 2c).

3. Determination of properties

Determination of selected properties of the starting materials, brick batter and shards, was completed according to relevant standards and devices that are listed in Table 3.

a)
b)
c)

Figure 2 Klinopur – Mn a) original; b) after contact filtration; c) after contact filtration - crushed

Table 1. Chemical composition of brick clay

SiO2	71,81 %	Na_2O	0,45 %
Al2O3	13,37 %	K_2O	1,46 %
Fe2O3	5,28 %	$CaCO_3$	0,63 %
TiO2	1,027 %	$MgCO_3$	0,74 %
CaO	0,46 %	Loss on ignition	4,71 %
MgO	0,91 %		

Table 2. Chemical composition of zeolite dust.

SiO2	70,2 %	MnO	0,02 %
Al2O3	12,4 %	K_2O	3,62 %
Fe2O3	1,52 %	CO_2	0,02 %
TiO2	0,19 %	SO_3	0,03 %
CaO	3,28 %	P_2O_5	0,02 %
MgO	0,62 %	Loss on ignition	7,45 %

Table 3. List of used technical standards, procedures and equipment for the determination of individual characteristics

Characteristics	Technical standard-procedures-equipment
Working moisture content, %	STN 72 1074
Linear drying shrinkage, %	STN 72 1565, part 5
Drying sensitivity, %	STN 72 1073
Linear firing shrinkage, %	STN 72 1565, part 5
Total change, %	STN 72 1565, part 5
Weight loss by firing, %	STN 72 1565, part 6
Water absorption by boiling, %	STN 72 1565, part 6, art.8
Apparent porosity, %	STN 72 1565, part 6
Bulk density, kg/m^3	STN 72 1565, part 6
Pore volume	High-pressure mercury porosimeter set Thermo Finnigan Pascal 240 from Thermo Scientific
Median pore radius	

The samples were prepared from milled clay from the brickyard in Nitrianske Pravno. The following individual ingredients were added to this basic raw material in various weight percentages (2,5; 5; 7,5 and 10%): zeolite dust exhausts (Z), raw (ZNF) and crushed Klinopur - Mn after contact filtration (ZPF).
A batter of constant plasticity was prepared from the ingredients (Pfefferkorn = 33 ± 0,5 mm) according to STN 72 1074. Such prepared batters were left for 24 hours in a humid environment. Once this was completed, test samples of dimensions 100x50x20 mm were made, and these were stored on perforated grills, where the values for the Bigot's curve were determined over a period of 48 hours. Before the samples were placed in the oven, they were dried in a laboratory dryer until constant weight was reached. Firing was carried out in an electric laboratory oven with a controlled firing regime. There was a stable oxidizing environment in the oven. A burning curve applied in brickyard in Nitrianske Pravno with firing temperature of 1060 ° C, was used for the firing.

4. Achieved results and discussion

Results related to the characteristics of brick materials with ingredients before and after firing are shown in Table 4.

Table 4. Characteristics of brick materials with ingredients before and after firing

Characteristics	D	W	DS	DP	DC	SP	NV	ZP	ρv	CNS
	%	%	%	%	%	%	%	%	kg/m^3	-
Without ingred.	0	23,90	-7,45	-3,00	-10,45	4,83	8,81	18,62	2114	1,477
Z	2,5	24,45	-7,60	-3,08	-10,68	4,87	9,08	19,05	2099	1,326
	5,0	24,67	-7,65	-3,15	-10,80	4,96	9,22	19,32	2095	1,253
	7,5	24,70	-7,67	-3,17	-10,84	5,03	9,45	19,73	2088	1,235
	10,0	24,17	-7,06	-3,21	-10,27	5,08	9,54	19,44	2038	1,207
ZNF	2,5	23,97	-7,25	-2,80	-10,05	4,71	9,12	19,15	2100	1,285
	5,0	24,04	-7,10	-2,82	-9,92	4,77	9,73	20,13	2069	1,137
	7,5	24,10	-7,03	-2,90	-9,93	4,84	10,78	22,07	2047	1,078
	10,0	23,62	-6,70	-2,95	-9,65	4,90	11,16	22,71	2035	1,069
ZPF	2,5	24,37	-7,41	-3,13	-10,54	4,82	9,13	19,07	2086	1,394
	5,0	24,43	-7,26	-3,20	-10,46	4,89	8,90	18,58	2088	1,241
	7,5	24,48	-7,11	-3,30	-10,41	4,93	8,83	18,45	2090	1,147
	10,0	24,28	-7,00	-3,39	-10,39	4,98	8,43	17,66	2095	1,139

Working moisture content – W
The study demonstrated an interesting phenomenon. When applying the particular ingredients until a dose of 7,5%, there was some increase in working moisture. At 10%, however, we observed a decrease in moisture. It is probable that the zeolite products at this dose started acting in the brick clay thixotropically.

Linear drying shrinkage - DS
In all three cases, we observed a decrease of linear drying shrinkage, as they are actually non-plastic materials. The values for the ZNF ingredient were shown to have the largest decrease because this ingredient is characterized by the thickest granulometry.

Linear firing shrinkage- DP
The presence of potassium in the zeolite products, which manifested as a flux, caused gradual increase in the value of linear firing shrinkage. This was most reflected in granulometric fine ingredients (Z and ZPF). Thicker granulometry in the ZNF ingredient slightly slowed down this effect. Moreover, the presence of small amounts of iron in the ZPF ingredient compared to the ingredient Z, resulted in a slight increase of the melting effect.

Total change - DC
The total change represents a total sum of the linear drying and firing shrinkage.

Weight loss by firing - SP
In all three cases, we can see a gradual increase of this value with the increasing dosage of the ingredients. This phenomenon is caused by the zeolite products themselves, which are characterized by a weight loss of around 8% by firing. In addition, greater softness of the ingredients caused a slight increase in the loss by firing.

Water absorption by boiling - NV
When applying the ingredients Z and ZNF, we saw an increase of absorption values with increasing their dosage. Conversely, in the case of the ZPF ingredient, there is an opposite trend. During a mutual comparison of these samples, the determining factor may be only the higher value of linear changes by firing and the softness of the ingredient itself.

Apparent porosity - ZP
The values of apparent porosity are closely related to the boiling water absorption values, as these are considered in the calculation of the apparent porosity of samples.

Bulk density - ρv
As in the previous case, the values of bulk density depend on the boiling water absorption values and apparent porosity. In case of the samples of the Z and ZNF ingredients, we observed a significant decrease in bulk density by increasing their dosage. When applying the ZPF ingredient, the bulk density values remain almost the same.

Drying sensitivity - CNS
In all three applications, we observed a significant decrease in the drying sensitivity values. The most dramatic decrease was in the case of the ZNF ingredient, which actually acted as a typical opening material.

Frost resistance
In terms of frost resistance of burn shards, the most important are the results of the pore structure of the burnt shards characterized by volume and median pore radius shown in Table 5. In all three

applications at the dose of 10%, we observed an increase of pore volume. In the case of median pore radius, a decrease occurred only when ZPF was applied, but in the other two cases, we saw an increase. In particular, an increase of 121,7% by the ZNF ingredient is worth attention.

Table 5. Volume and median pore radius of the burning shards

Ingredient	Bulk density mm^3/g	Median pore radius nm
without ingredients	97,3 (100,0 %)	2026 (100,0 %)
Z 10 %	100,3 (103,1%)	2056 (101,5 %)
ZNF 10 %	110,0 (113,1 %)	2466 (121,7 %)
ZPF 10 %	120,9 (124,3 %)	1806 (89,1 %)

5. Conclusion

The results of this study suggested the possibility of applying zeolite wastes in brick manufacture. In all of the three cases and particularly in the case of the ZNF ingredient, the wastes can be used to reduce sensitivity during drying of the brick materials.

The application of the ZNF ingredient could be also considered in the manufacture of roofing tile because with a small increase in pore volume, the median pore radius value increased significantly compared to the comparative sample. This could contribute to increasing of frost resistance; however, further studies to test frost resistance are necessary before any conclusions can be made.

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ANALYSIS OF THE CUTTING PARAMETERS IMPACT ONTO TOOL LIFE IN DUPLEX STAINLESS STEEL TURNING PROCESS

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Abstract
The purpose of the study is to determine the coated carbide tool life and the tool point surface topography. The study included determining cutting conditions in the process of turning the DSS and designating the wear curve. In case of machining greater resistance to abrasive wear of the tools which were coated with Al_2O_3 has been demonstrated.

Keywords:
Duplex Stainless Steel, machining, turning, tool life, wear

Nomenclature:
a_p - depth of cut in mm
f - feed rate in mm/rev
v_c - cutting speed in m/min
T - tool life
VB_B - width of flank wear in mm
VB_{Bmax} - the maximum width of the flank wear in mm
DSS - Duplex Stainless Steel

1. Introduction

According to companies producing construction materials - duplex stainless steel is gaining importance, which is reflected in the wide range of these products available in the market. However, the manufacturing process, the machining, in particular, poses considerable difficulties. One limitation of the efficiency of turning this type of steel is the wear of a tool point. The wearing process of a tool point, which is largely dependent on cutting parameters, is an important factor. The wear of a tool point leads to deterioration in quality of machined surface and, consequently, to lower efficiency and productivity. Machining DSS due to the characteristic two-phase microstructure is difficult and in order to overcome occurring problems, materials with high durability, reliability and efficiency should be used. In recent years, machinability of austenitic steels has been dealt by researchers such as Paro, J. et al., Akasawa T. et al., Abou-El-Hossein KA et al., Charles J. et al., Kosmač A., Cunat PJ, and Ciftci I. [1, 2, 3, 4, 5, 6, 7, 8], while machining of DSS has been described by Bouzid Sai W. and J. L. Lebrun [9]. Many production companies use coated carbide tools or high speed steel for processing of DSS. According Gunn'a [10] low-alloyed DSS such as S32304 while being machined by tools from high speed steels behave in a manner similar to austenitic types such as 316 or 317. However, during the machining of coated carbide tools steel behaves in a manner similar to 317LN and 317LMN. Modern types of DSS are harder to machine than the types produced before this one. The reason for this is higher content of austenite phase and nitrogen. The increase in content of alloying elements such as nitrogen and molybdenum makes machinability of these steels less effective. The use of coated carbide tools for machining of DSS requires a deeper study of tool wear and associated wear mechanisms. The article focuses on basic research problems of tool wear of coated carbide with a layer of CVD-Ti (C, N)/Al_2O_3/TiN in turning DSS of ferritic-austenitic structure. The main purpose of this study was to determine the effect of cutting speed as key process factor controlling tool life. Increasing cutting speed to a scope greatly exceeding conventional machining is now recognized as the primary direction of production capacity and efficiency growth as well as quality and accuracy improvement [11]. As the method of rational selection for DSS machining a static determined selective-multivariate uniform static - rotatable PS/ S-P:λ program has been selected [12]. The research program included an assessment of: influence of cutting parameters impact onto tool life, rake face as well as flank wear in the process of turning. Tool wear data were used to determine characteristic wear curves.

2. Experimental techniques

Workpiece and cutting tool materials

Machined material was 1.4462 (DIN EN 10088-1) steel with a ferritic-austenitic structure containing about 50% of austenite. The ultimate tensile strength UTS=700 MPa, Brinell hardness - 293±3 HB. The elemental composition of the machined material and technical details of the cutting tools are given in tables 1 and 2 respectively. Cutting tool inserts of TNMG 160408 designation clamped

in the tool shank of ISO-MTGNL 2020-16 type were employed.
Based on the industry recommendations a range of cutting parameters T1: v_c = 50 ÷ 150 m/min, f = 0.2 ÷ 4 mm/rev, a_p = 1 ÷ 3 mm was selected. The experiments performed with the tool point T2 were comparative studies and that is why the cutting parameters were: v_c = 50, 100 and 150 m/min, f = 0,2, 0,3 and 0,4 mm/rev, a_p= 2 mm. The study was conducted within a production facility. The research program was carried out on a CNC lathe 400 CNC Famot Pleszew plc.

Table 1. Chemical composition of 1.4462 duplex stainless steel

Element	%C max	%Si max	%Mn max	%P max	%S max	%Cr	%Ni	%Mo	%N	Others
[%] at.	max 0,03	max 1,00	max 2,00	max 0,030	max 0,020	21,0 23,0	4,50 6,50	2,50 3,50	0,10 0,22	-

Table 2. Cutting tool specification

Tool	Substrate	Others
T1	Hardness: 1350 HV3 Grade: M25, P35	Coatings: Ti(C,N)-(2 μm) (Top layer) Al_2O_3-(1,5 μm) (Middle layer) TiN-(2 μm) (Bottom layer) Coating technique: CVD
T2	Grade: M35, P35	Coatings: TiN-(2 μm) (Top layer) Ti(C,N)-(2 μm) Ti(N,B)-(2 μm) TiN-(2 μm) Ti(C,N)-(2 μm) Ti(C,N)-(2 μm) (Bottom layer) Coating technique: CVD

Tool life plan

The required number of experimental points is N = 2^3+ 6 + 6 = 20 (Table 3). There are eight factorial experiments (3 factors on two levels, 2^3) with added 6 star points and centre point (average level) repeated 6 times to calculate the pure error [13]. For the purpose of the experiment a program that estimates parameters of the model second-order polynomial in the form $y = (a_0 + a_1{*}x_1 + a_2{*}x_2 + a_3{*}x_3)^2$ has been developed. The program was written in Matlab and it allows generating three-dimensional graphs and plots of one variable. The tests were performed on a CNC lathe, hence the test plan had been adjusted to the GE Fanuc Series 0 - T controlled machine program.

Table 3. Coded indication of the study plan

Test No.	Coded factors			Decoded real value		
	x_1	x_2	x_3	v_C [m/min]	f [mm/rev]	a_p [mm]
1	-1	-1	-1	70	0,24	1,4
2	-1	-1	+1	70	0,24	2,6
3	-1	+1	-1	70	0,36	1,4
4	-1	+1	+1	70	0,36	2,6
5	+1	-1	-1	130	0,24	1,4
6	+1	-1	+1	130	0,24	2,6
7	+1	+1	-1	130	0,36	1,4
8	+1	+1	+1	130	0,36	2,6
9	-1,682	0	0	50	0,3	2
10	1,682	0	0	150	0,3	2
11	0	-1,682	0	100	0,2	2
12	0	1,682	0	100	0,4	2
13	0	0	-1,682	100	0,3	1
14	0	0	1,682	100	0,3	3
15	0	0	0	100	0,3	2
16	0	0	0	100	0,3	2
17	0	0	0	100	0,3	2
18	0	0	0	100	0,3	2
19	0	0	0	100	0,3	2
20	0	0	0	100	0,3	2

Wear analysis

After cutting attempts values of flank wear were measured with the use of an optical microscope.

3. Results and discussions

Wear curves

The examination the process of wear of the tool point particularly in industrial processes showed that the most common type of wear was the average and maximum wear bandwidth of abrasive wear on the major flank in zone B - respectively VB_B (Figure 1) and VB_{Bmax} (Figure 2). Therefore, the experiment adopted this kind of criterion. Tool-life curves were determined for the center parameters of a research program for the T1 tool point. As one may notice, the VB_B curve (Figure 1) is typical of the steel machining with the average cutting speed, with no special cooling or of little intense cooling. This may indicate a three discernible, typical periods of tool wear. While analyzing the results for VB_{Bmax} wear curve (Figure 2), a greater value of wear can be noticed; this may indicate irregularly worn major flank.

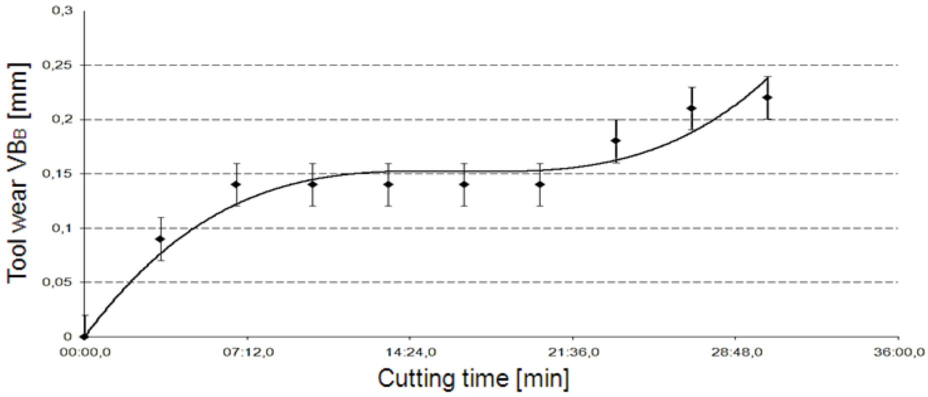

Figure 1. Tool wear VB_B for coated carbide tools T_1

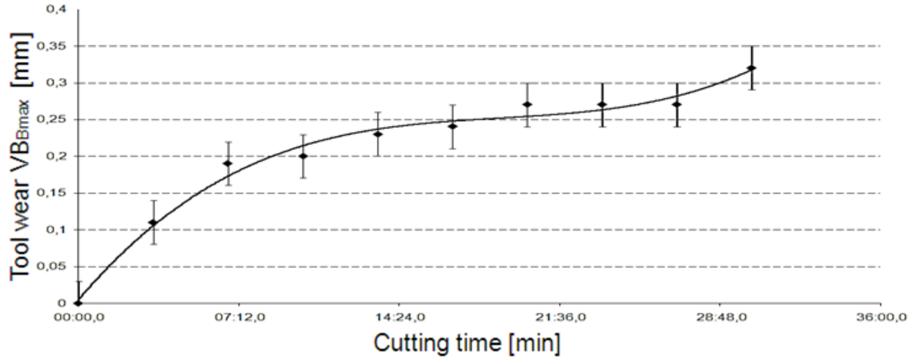

Figure 2. Tool wear VB_{Bmax} for coated carbide tools T_1

Tool life

Figure 3 shows the tool life after machining DSS with T1 tool under dry cutting conditions. The results obtained by modeling on the basis of adopted program PS/DS-P:λ was presented as a three-dimensional plot and two plots of one variable in sequence showing the depth of cut and cutting speed for the parameters from the point of the centre. For a f = 0,3 mm/rev feed and a cutting speed of v_c = 100 m/min the tool life of the tool point takes the greatest value for the depth of cut a_p = 1 mm and a_p = 3 mm and amounts to T = 31 min and T = 23 min. The minimum value was observed for the depth of cut of a_p = 2,3 mm at the tool life amounting to T = 20 min. For the f = 0,3 mm/rev feed and cut depth of a_p = 2 mm, the greatest tool life values were observed for v_c = 50 m/min and v_c = 150 m/min and they amounted to T = 44 min and T = 24 min. The minimum value of the tool life T = 19 min was v_c = 118 m/min. Analyzing the impact of cutting speed onto the tool life for a T1 tool point (Figure 4) and T2 tool point (Figure 5), it can be noticed that with the increasing cutting speed the tool life decreases for each of the feeds. The tool life decreases for the cutting speed of 100 to 130 m/min depending on the feed value. The higher the feed, the less the function moves to the v_c axis increasing its value. Tool life takes larger values for the T1 tool point. The reason for this is probably a greater resistance to abrasive wear of tools with an Al_2O_3 coating.

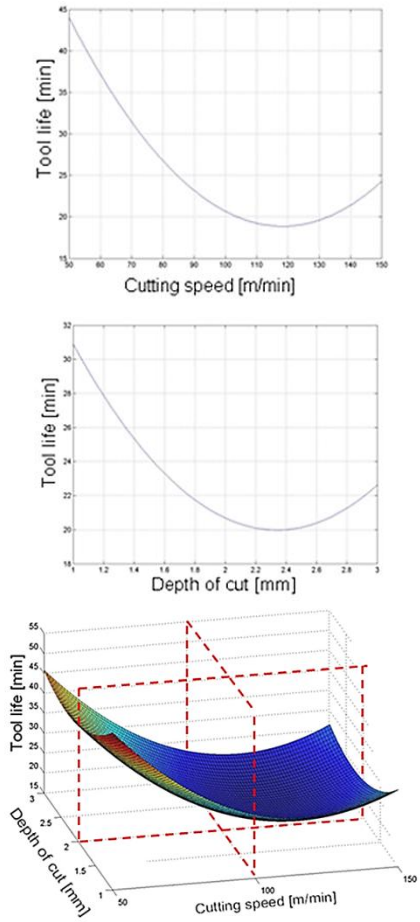

Figure 3. Tool life for centre point parameters (T1)

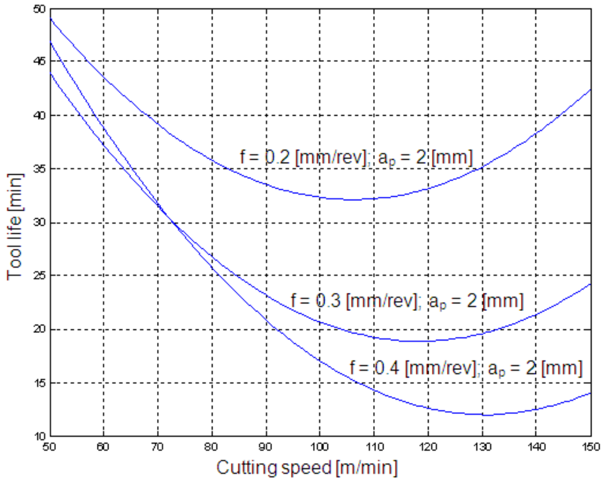

Figure 4. Tool life in dry machining of DSS with coated carbide tools T1

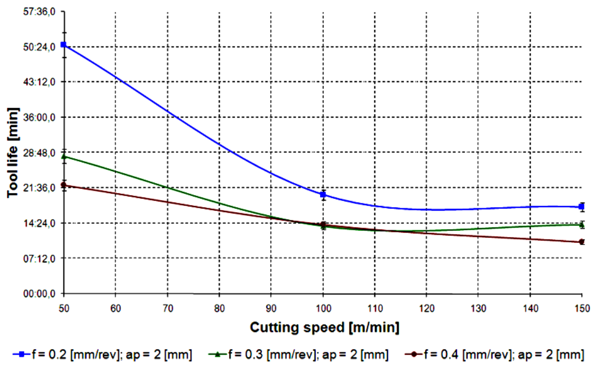

Figure 5. Tool life recorded in dry machining of DSS with coated carbide tools T2

4. Conclusions

The DSS machining, the following difficulties occur: it is difficult to control the chip, there are excessive thermal and mechanical loads onto the tool point, strong adhesive interaction leading to the formation of built-up edge occur, and accelerated wear of cutting edge happens. These lead to:

I. In the process of DSS turning the course of coated carbide tool point wear for the parameters of a test centre program shows a typical shape of the normal wear curve.
II. Increasing the cutting speed increases the intensity of wear of the cutting edge.
III. CVD-Ti(C,N)/Al_2O_3/TiN coated carbide tools indicate higher resistance to abrasive wear and they can be recommended to roughing machining of DSS, optimally with cutting speeds of 130 - 150 m/min.

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COMPARATIVE ANALYSIS OF 3D DIGITIZATION SYSTEMS IN THE FIELD OF DENTAL PROSTHETICS

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Abstract
The paper deals with the application of 3D digitization systems in the field of dental prosthetics, and attempt to contribute in this field through comparative analysis of this kind of systems. Beside the general overview and analysis of nine different systems, this paper presents experimental results of comparative accuracy analysis of two high-end 3D digitization systems – Atos III Triple Scan and Zeiss Metrotom 1500.

Keywords:
3D digitization, accuracy, dental prosthetics

1. Introduction

Dental prosthetics has always maintained close relationships with engineering disciplines, mostly relying on production engineering. Rapid development of computer-aided technologies, which completely transformed production engineering, also left an indelible mark on dental prosthetics. During the last decade, efforts have been concentrated towards advancement in modelling and manufacture of dental replacements by introducing modern computer equipment and state-of-the-art materials and machining technologies. Amongst the modern engineering technologies which have found broad application in this area, the most widely used are three dimensional (3D) digitization, computer aided design (CAD), reverse engineering (RE), computer aided engineering (CAE), computer aided manufacturing (CAM), rapid manufacturing (RM), rapid prototyping (RP), computer aided inspection (CAI), etc. The development and implementation of such technologies and systems have paved the way towards significant advancement of conventional modelling, manufacture and inspection of dental replacements [1-3].
This paper focuses on 3D digitization systems and their application in the field of dental prosthetics, with emphases on the accuracy analysis.

2. 3D digitization systems in the field of dental prosthetics

Contemporary approaches of dental restorations' design, in general, include 3D digitization and virtual design (i.e., RE-CAD modelling).
The modelling phase starts with the 3D digitization of the patient's cast. This process can be dual, regarding the applied 3D digitization methodology – extra oral or intra oral.
Application of extra oral 3D digitization systems usually includes acquiring a dental impression and extra oral scanning of a gypsum model produced from the impression [2,3]. However, the need for making impression could be replaced by the application of intra oral scanning or CT [4].
3D digitization is one of crucial segments in dental computer aided (CA) technologies. For that reason systems for 3D digitization have been rapidly developed during the last several years [5]. Within this part, the review study on the 3D digitization systems with the application in the field of dental prosthetics is presented. The study was conducted on the basis of available data collected from literature, manufacturers, distributors and direct users of the systems. Analysis included specialized extra oral dental 3D digitization systems and 3D digitization systems for more general purposes.
Within extra oral group of 3D digitization systems, three types of systems were analyzed: (i) contact systems, (ii) noncontact optical systems and (iii) noncontact systems based on computed tomography (CT).
The analysis included a total of 9 systems, and the results of the analysis are given in Table 1.

3. Comparative analysis of the accuracy of an optical and CT based 3D digitization systems

A long-term improvement of 3D digitization systems and harmonization of their technical features with the requirements of dental practice have allowed practical implementation of novel methods for 3D digitization [1,2]. Despite their significant advancement, novel technologies of 3D digitization have not yet replaced the conventional method of taking imprints of prepared teeth. Unlike conventional imprints, which represent negative copies of teeth and the surrounding tissue, 3D digitization collects data on the coordinates of surface points and transfers them into digital form [5]. Bearing in mind that both methods represent initial step in the technological chain of dental replacement, their accuracy and precision play vital role in providing quality marginal sealing.

Table 1. Extra oral 3D digitization system – technical features' overview

System / Feature	Denti Cad, BEGO - Bremen	DSC Precident - DSC Austenal Dental AG	Procera Forte - NobelBiocare	Cerec inEOS	KAVO	Atos III Triple Scan- GOM	MicroScribe G2 Immersion (articulated arm)	Contura G2 Zeiss (CMM)	METROTOM 800 Zeiss (industrial CT)
Specialized / General purpos	S	S	S	S	S	G	G	G	G
System's mobility	●	●	●	●	●	●	●	∅	∅
Contact	●	●	●	∅	∅	∅	●	●	∅
Noncontact	∅	∅	∅	●	●	●	∅	◖	●
Manual / Automated	M	M	A	A	A	A	M	A	A
Internal (invisible) surface digitization	∅	∅	∅	∅	∅	∅	∅	∅	●
Fixturing need	●	●	●	∅	∅	∅	●	●	∅
Sensitivity on surface reflection	∅	∅	∅	●	●	●	∅	∅	∅
Sensitivity on surface hardness	●	●	●	∅	∅	∅	●	●	∅
Sensitivity on material density	∅	∅	∅	∅	∅	∅	∅	∅	●
Speed	▼	▼	►	▲	▲	▲	▼	▼	▲
Measuring uncertainty	/	/	1.7μm	/	10μm	/	0.2mm	1μm	/
Resolution	/	/	/	/	/	10μm	/	/	1900 x 1512 pixels
Price	▼	▼	►	►	►	▲	▼	►	▲
Application in practice	►	▼	▲	▲	►	▼	►	►	▼

3D digitization represents a measurement method which can utilize various working principles. Basic indicators of quality of 3D digitization are accuracy and precision. Accuracy represents the degree of closeness of measurements of a quantity to that quantity's true value, while the precision (also known as reproducibility or repeatability) is the degree to which repeated measurements under unchanged conditions show the same results [6].
In this paper comparative analysis of the application of two 3D digitization systems of more general purposes in the field of dental prosthetics has been presented.
The basis of this experiment is a method of CAD inspection that includes checking up geometric and dimensional deviations on the bases of CAD and 3D digitization models. Namely, a digitized representation of a physical model is checked for deviations against the nominal geometry defined by the CAD reference model [1,6].
Within the experiment, CAD inspection was used to measure and analyze deviations between the CAD reference model and experimental CAD models. The models were generated by 3D digitization of the stone replica. The digitized data were stored in STL file format.
The CAD reference model was generated by 3D digitization of the stone replica, using Atos III Triple Scan surface digitization device (Fig. 1). The experimental CAD model was generated by 3D digitization of the stone replica using Metrotom 1500 Zeiss (Fig. 2).
Measurements and comparative analyses of deviations were performed using GOM inspect V7

SR2 software.

Figure 1. Atos III Triple Scan from GOM

Figure 2. Metrotom 1500 from Zeiss

4. Results

The results of the comparative analysis included three types of analysis. Fig. 3 presents a result in a form of map of regions, where the different colours indicate respective deviations. It is clear that the majority of deviations are in positive direction, ranging from -0.05 to 0.1 mm, with the most concentration around 0.025 mm.

Another type of results is presented in Fig. 4, where coloured regions present deviation areas within 0-75%, 75-100% and over 100% of defined tolerance, in both directions – positive and negative. Fig. 4 shows that 70% of deviation regions lie between 0.01 and 0.05 mm, of which almost 60% fall in the "Pass" region. This type of result includes numerical values of areas in mm^2.

Finally, the third type of results is a 2D deviation analysis at the defined cross-sections (Fig. 5 and Fig. 6). The meaning of the coloured regions is the same as in 3D. Results presented in figures 5 and 6 confirms the conclusion from the 3D analysis that the majority of the deviations is in positive direction as well as that range between 0.01 and 0.05 mm.

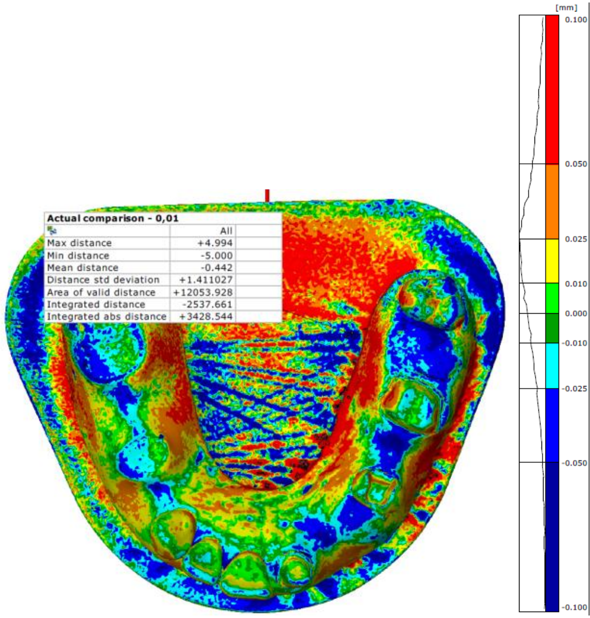

Figure 3. Resulting deviations in a map of regions form

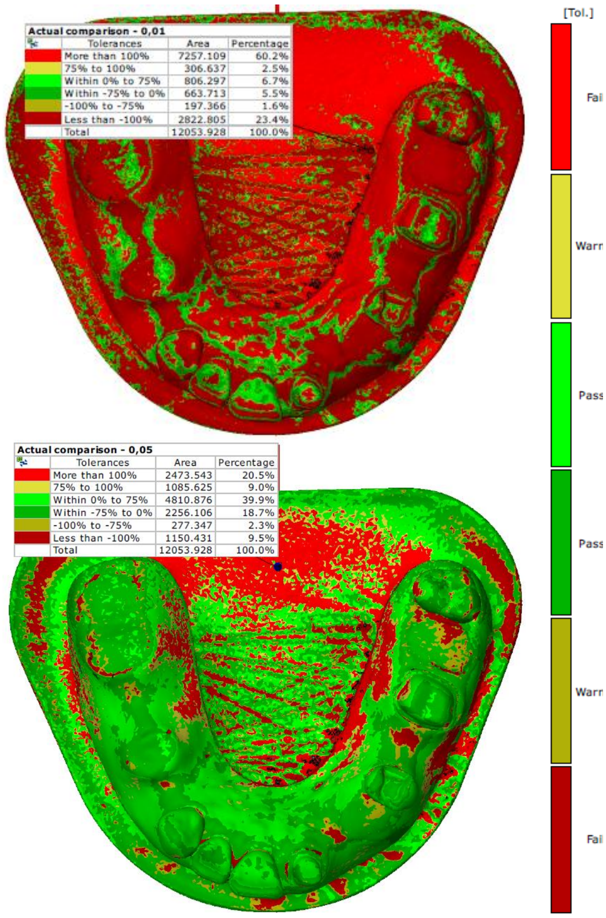

Figure 4. Resulting deviations in a form of areas classified according to level of tolerance

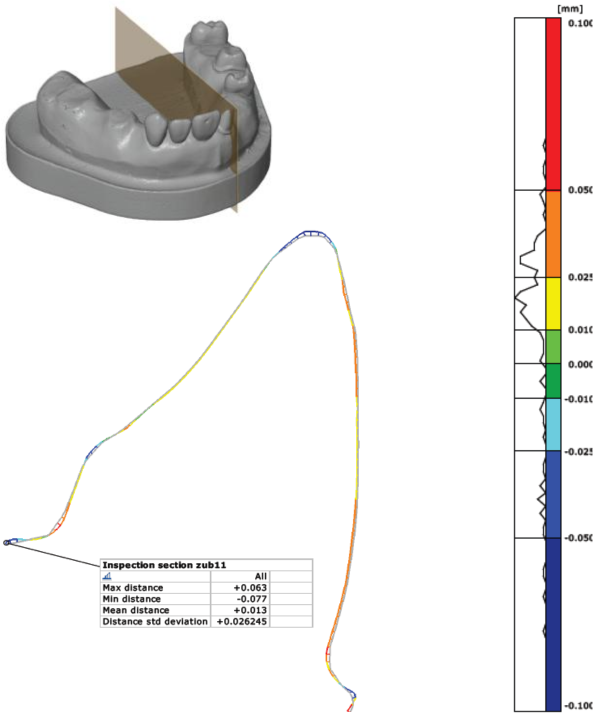

Figure 5. Resulting deviations in a map of regions form (in the defined cross-section)

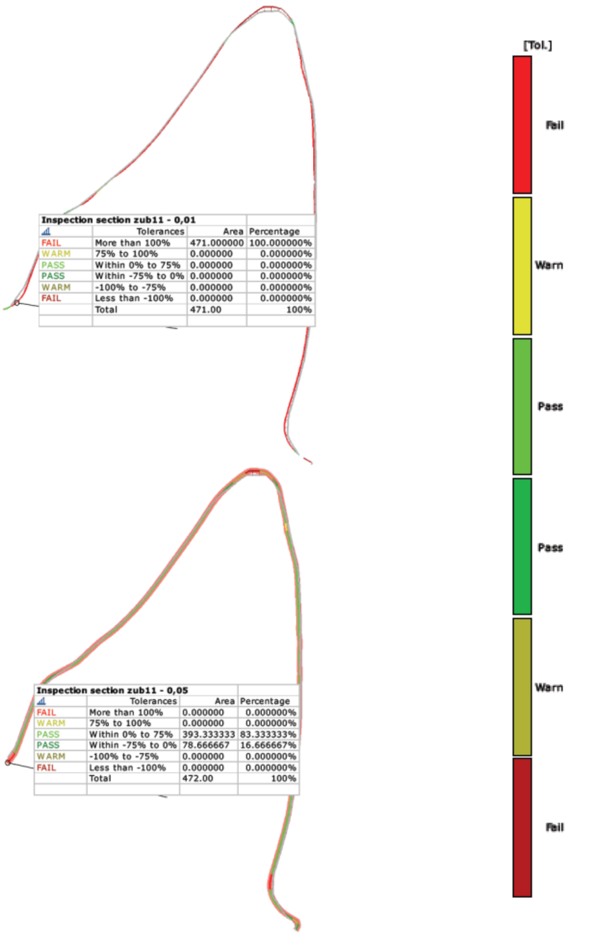

Figure 6. Resulting deviations in a form of areas classified according to level of tolerance (in the defined cross-section)

8. Conclusion

Within the paper the comparative analysis of 3D digitization systems from the dental prosthetics' point of view is given. After a overview and analysis of nine systems (five of specialized and four of more general purposes) based on their technical features, experimental results of specific comparative analysis of the accuracy of two high-end 3D digitization systems (Atos III Triple Scan and Zeiss Metrotom 1500) is presented.
The obtained result from conducted comparative analysis show that the majority of deviations are in positive direction and are concentrated around 0.025 mm. As the analysed 3D digitization systems are from the group of high-end quality and very expensive systems, the obtained results may be taken as disappointing. However, in the result's analysis some obvious limitations should be considered. These primarily include problems of models orientation and STL generation. The further research will be focused in those directions.

9. Acknowledgement

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ERP SYSTEM IN EDUCATION AND IN BUSINESS PROCESS

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Abstract
In this paper, MS Dynamics NAV 2009 system has been described from the educational and business process point of view. Some specific characteristics of the system and the flow of information and documentation have been presented. One of the aims of the paper is to motivate students and higher education institutions to participate in the program for academic institutions by which possibility to use such ERP system in education can be reached.

Keywords:
ERP systems, MS Dynamics NAV 2009, education

1. Introduction

On the initiative of Department for Industrial Engineering, Mechanical Engineering Faculty in Slavonski Brod became a member of Microsoft Dynamics Academic Alliance program [1]. By the membership in MDAA program, Mechanical Engineering Faculty in Slavonski Brod got the opportunity of using MS Dynamics NAV 2009 ERP (Enterprise Resource Planning) system and educational materials in teaching and research, as well as the ability to connect and share experiences with other members of this program. The specific characteristic of this ERP system is the Role center, i.e. each user has different interface depending on the task and activity she or he performs. There are 21 roles [2, 3]. Some of them are: president, accounting manager, bookkeeper, accounts payable coordinator, accounts receivable administrator, shipping and receiving–order by order, warehouse worker–warehouse management system, purchasing agent, project manager, resource manager, sales manager, sales order processor, production planner, machine operator. MS Dynamics NAV is widely used in small and medium sized enterprises and in education. It is also flexible and adaptive system, so we can find many examples of adaption to the particular enterprise. One of the examples is the development of the specific forensic system from MS Dynamics NAV for using all common applications of an ERP, but also for using all specific processes in forensic, from quote to analysis report [4].

2. Sales process

The sales process is the initiator of all other processes and activities. In the sales department, the contact with customer is established. Primary role centers are sales manager and sales order processor (Figure 1).

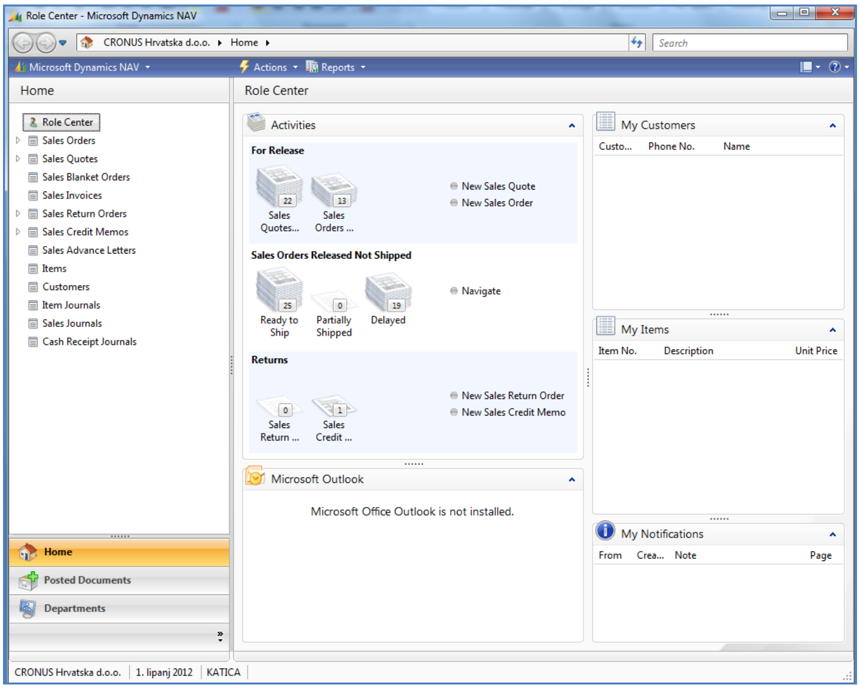


Figure 1. User interface of role center - sales order processor

Because the contact with customer is very important, the Customer card should be very carefully filled (general, communication, invoicing, payments, shipping and foreign trade). Attention must be paid to the addresses (for example, different addresses for the same enterprise for invoice and shipping), postings groups (general business posting group, VAT business posting group and customer posting group), payment terms and methods, invoice discounts (with predefined criteria), product discounts… Relevant documents are Sales quotes and Sales orders. Sales order can be generated from the sales quote and for the “make to order” production type, Production order can be made from Sales order. It can be concluded that there is a strong connection between different actions in the enterprise. Except from the connection between sales and production planning, there is also a strong link between sales and financial department (role centers accounts receivable administrator, bookkeeper, accounting manager) as well as sales and shipping and receiving role and warehouse worker, among others. Apart from Customer card, another prerequisite to send a quality sales quote to our customer is a properly filled Item card (general, invoicing, replenishment, planning, foreign trade, item tracking, e commerce and warehouse).

Product and inventory posting groups are also very important for the item because of journals as well as general ledger accounts.

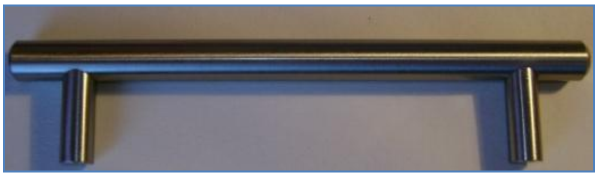
3. Production preparation process

For the production enterprises, carefully planning of production is significant. For this activity, the role center production planner is responsible, but the tasks of that role are connected with other roles and activities (for example sales, purchasing, warehouse, shop supervisor, machine operator...). Important tasks to do are to make Bill of material, Routing and Production order. Therefore, navigation window of production planner user interface consists of data about above mentioned activities as well as the data about sales orders (make to order), purchase orders, vendors, items, capacities, journals and worksheets. It differs significantly from the role center in Figure 1. Bill of material is a list of parts and raw materials of finished product. To make a bill of material for some product, the data about finished product and raw materials should be previously defined on the Item card. In Figure 2, there is an example of Production bill of material for the furniture handle (view Quantity explosion).

Quantity Explosion of BOM
As of 01.06.12
CRONUS Hrvatska d.o.o.

Level	No.	Description	BOM Qty.	Unit of Measure Code	Total Qty.
Item: No.: 100					
100	**Furniture handle**				
1	110	Handhold	1	PIECE	1
1	120	Connector	2	PIECE	2

a)



b)

c)

Figure 2. Production bill of material - a) for the furniture handle - b) and c)

Except from Bill of material, Routing should be defined. Times (setup-adjusting, run-executing, wait-waiting, move-transporting) and machine or work centers for the operations to make product are very important as well as proper data on Work or Machine center card. Quality Bill of material and Routing are prerequisites for a good planning of Production order (status: planned, firm planned, released and finished). Figures 3 and 4 present a Routing for the production of semi-finished product Handhold (it is a part of furniture handle which Bill of material is given in Figure 2) and planned Production order for the production of 1500 pieces. After the releasing of Production order, there is a need to post the consumption of materials on the Consumption journal and the executed operations on the Output journal.

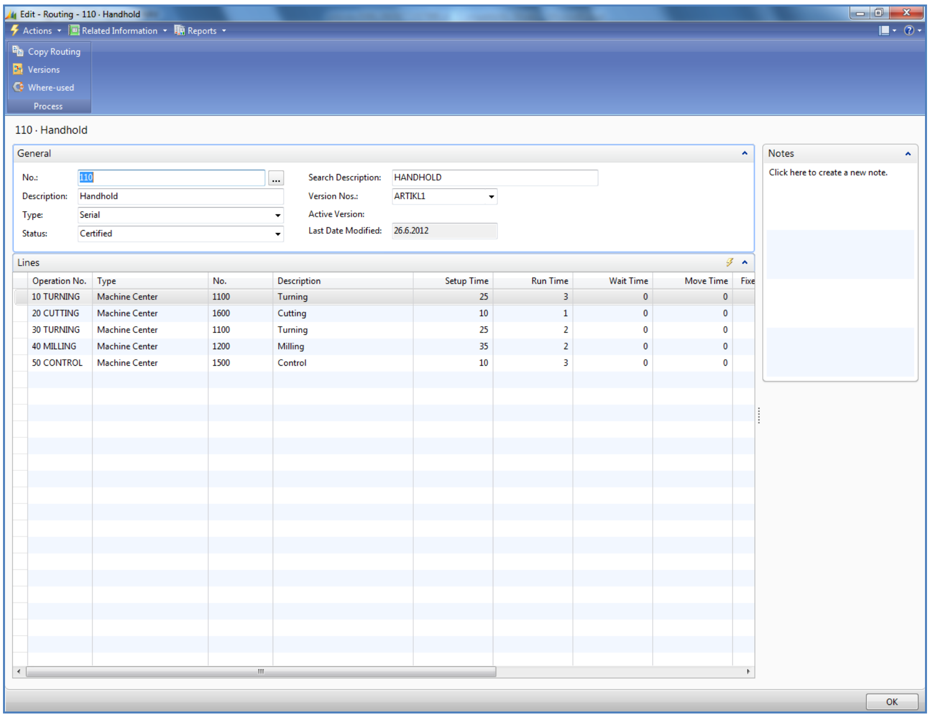


Figure 3. Routing for the production of semi-finished product Handhold

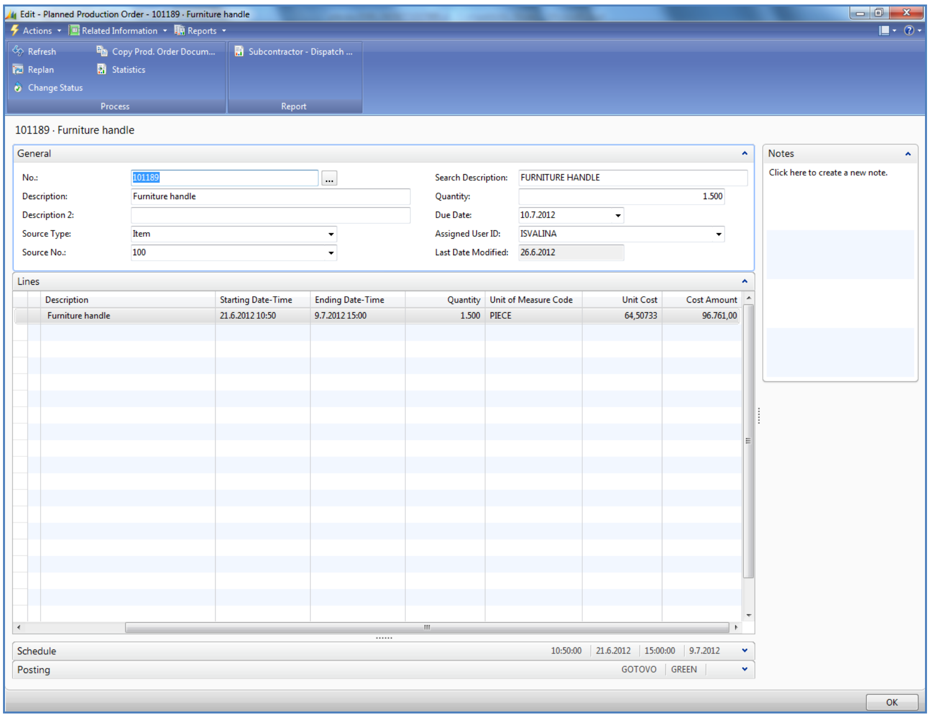


Figure 4. Planned Production order for the Furniture handle

4. Purchasing process

In order to have needed raw materials in stock and to be possible to release Production order, some activities in the purchase process have to be accomplished. Contrary to the sales process, where the communication with customer is important, at the purchasing process, contact with vendors is significant. So, the data have to be entered to the Vendor card. Prior the Purchase order, there is a possibility of sending request for Purchase quote to a particular number of vendors and to make decision of the best supplier. Figure 5 presents the Purchase order made from Purchase quote of chosen vendor, for the raw material needed for the production of semi-finished products handhold and connector which are on the Bill of material of the product Furniture handle (Figure 2).

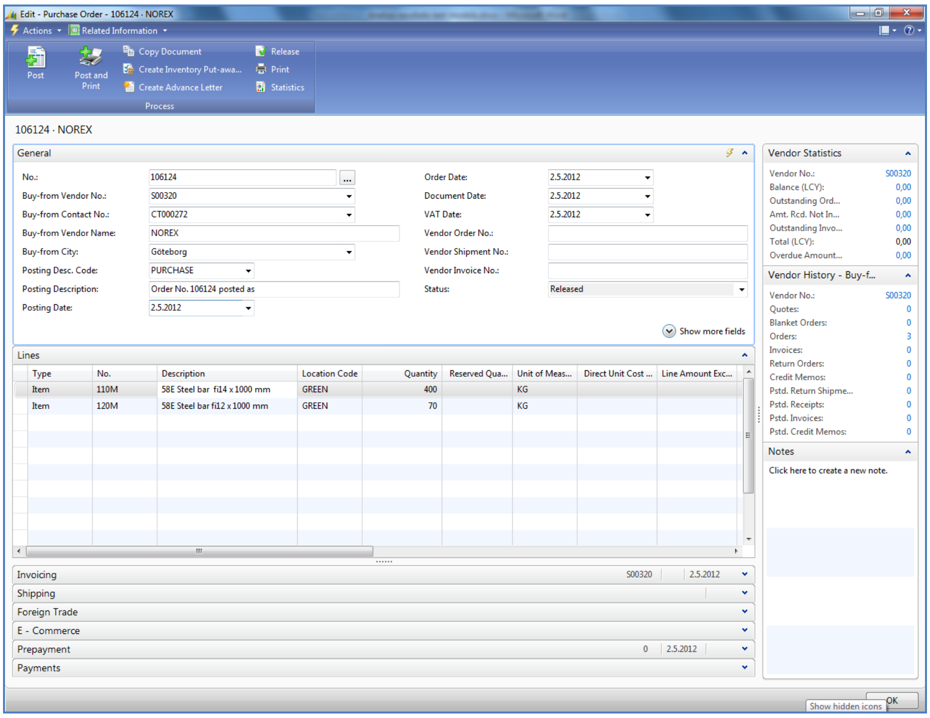


Figure 5. Purchase order for the raw material

5. Shipping and receiving

A special role is Shipping and receiving in the warehouse which has to receive items from the vendor, but also to pack and ship items to the customer from the warehouse. So this role has to deal with sales orders to ship (outbound) and respected purchase orders to receive (inbound) and also with purchase and sales returns. Very important documents are sales shipments and purchase receipts. After the receiving or the shipping there is a need of posting (receive/ship, invoice, receive/ship and invoice). As previously mentioned, the actions of this role also affect the changes in other modules (financial changes after the billing; inventory is increasing or decreasing...).

6. Conclusion

A wide variety of analyses and reports is possible to get in MS Dynamics NAV (the best vendors and customers, statuses of different documents and tasks, statistics of sale for salespersons, expected and actual costs...). It can help and improve making decisions in business process; actually it is impossible to do business without ERP system and to be competitive. Furthermore, regarding education, MS Dynamics NAV system is a great support to learn about the flow of information and documentation in production process for the students. The theoretical knowledge given to students through the lectures is well illustrated, improved and enriched with practical work by using the MS Dynamics NAV. Practical learning experiences are acquired and the students will be well prepared to adapt to the requirements of the world-wide labour market. The students will be able to apply specific skills about the ERP systems and to improve competition of the enterprise.

7. Acknowledgement

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PREPARATION OF STABLE SUSPENSIONS FOR SLIP CASTING OF ALUMINA-ZIRCONIA COMPOSITE

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Abstract
The effect of commercial dispersant DOLAPIX CE64 on rheological behavior of 60 wt. % Al_2O_3-t-ZrO_2 aqueous suspensions was investigated. The mass ratio of Al_2O_3:t-ZrO_2 in prepared concentrated aqueous suspensions was 85:15. Different amount of DOLAPIX CE64 was added to each suspension. Stability of prepared suspensions was determined by zeta potential measurements at different pH values and by determination of rheological properties (flow curves and rheological parameters). Obtained results showed that all suspensions with the addition of DOLAPIX CE64 were stabilized satisfactorily, while the sample without dispersant was unstable. All prepared suspension showed pseudoplastic behavior, which was confirmed by successful application of Power law and Herschel-Bulkley models on rheological data. Measured zeta potential and rheological parameters showed that DOLAPIX CE64 is excellent and efficient dispersant for concentrated Al_2O_3-t-ZrO_2 suspensions.

Keywords:
Al_2O_3-t-ZrO_2 composite, slip casting, zeta potential, rheological parameters

1. Introduction

Monolithic alumina (Al_2O_3) is widely used oxide ceramics, due to its satisfying properties, such as high strength and hardness, temperature stability, high wear resistance and corrosion resistance. However, low fracture toughness is its greatest disadvantage. The addition of yttria-stabilized tetragonal zirconia (t-ZrO_2) to alumina results in a composite ceramic material, which has higher fracture toughness and strength than alumina [1-3].

Slip casting processing of ceramics is a relatively easy and economical technology. In order to produce high-quality green product and, subsequently, sintered material, it is essential to prepare stable suspension with adequate rheological properties. Stability of a suspension lies in the ability of solid particles to remain well dispersed in the liquid phase. If the solid and liquid phase separate, due to the agglomeration of particles, the suspension is considered unstable. In order to prevent this, small amounts of additives (dispersants) are added to the slips. The additives disable interactions between ceramic particles by means of electrostatic or electrosteric stabilization. The effect of different additives on the stability of various suspensions is intensively investigated, while the preparation of stable suspension is crucial for many technologies (e.g. slip, gel and centrifugal casting, injection molding, dip coating) [1, 2]. Recently, polyelectrolytes are widely used as dispersants, due to their greater stability and efficiency. They provide electrosteric stabilization [3-16].

Suspension stability can be determined by sedimentation tests, zeta potential and particle size measurements, as well as determination of rheological parameters [3-16]. Zeta potential values of colloidal suspensions indicate the interactions between particles. When the absolute value of zeta potential is greater than or equal to 20 mV, the observed suspension can be considered as stable, because all particles have high, positive or negative, charge. These particles tend to repel each other, so they won't agglomerate.

In this paper, the stability of prepared suspensions was investigated by zeta potential measurements, as well as rheological parameters determination. Apparent viscosity was measured at different shear rates and used for defining flow curves. They show dependence of the shear stress on the shear rate, which can give valuable data about the suspension stability. Prepared aqueous Al_2O_3-t-ZrO_2 suspensions are characterized as non-Newtonian, which means their viscosity changes with the shear rate change. For mathematical description of these fluids several models have been developed [10-16]. In this paper, Power law and Herschel-Bulkley models were chosen, because they haven't been used for Al_2O_3-t-ZrO_2 systems before.

2. Method

Zeta potential and rheological parameters were measured on aqueous Al_2O_3-t-ZrO_2 suspensions. For preparation of these suspensions, following components were used:

- High purity α-Al_2O_3 powder, with an average particle size of 300 nm (Alcan, Canada),
- High purity t-ZrO_2 powder – tetragonal modification of zirconia ceramics, stabilized with 8 mol % of yttria. Average particle size was 300

nm (SkySpring Nanomaterials, Inc., Texas USA),

- Dispersant DOLAPIX CE64, alkali-free carboxylic acid (Zschimmer & Schwarz GmbH &Co KG, Germany). The average molecular mass of Dolapix CE64 is 320 g/mol, and it is a polyelectrolytic, ethanolaminic salt of citric acid.

For zeta potential measurements, 0,01 wt.% suspensions of Al_2O_3-t-ZrO_2 were prepared. In all suspensions the mass ratio of Al_2O_3:t-ZrO_2 was 85:15. The suspensions contained various amount of dispersant DOLAPIX CE64: 0, 0,4, 0,5, 0,6 and 1 wt.%. All suspensions were homogenized ultrasonically for 45 minutes.

Zeta potential usually depends on the pH value of prepared suspension. In this investigation, the zeta potential was measured in the wide pH range (approximately between 2 and 12). The pH value was adjusted by addition of HCl or NaOH (both concentrations were 0,1 mol/L). Zeta potential was measured on Zetasizer 3000, Malvern, UK.

For rheological measurements, 60 wt.% Al_2O_3-t-ZrO_2 aqueous suspensions, containing 0,4 and 1 wt.% of DOLAPIX CE64, were prepared. The mass ratio Al_2O_3:t-ZrO_2 was 85:15. Suspensions were homogenized in planetary ball mill (Retch, PM 100, Germany), using α-Al_2O_3 bowl and balls. Homogenization lasted for 120 min, with disc speed of 300 rpm. Subsequently, air bubbles were removed in ecsicator during 5 min, then in ultrasonic bath for 5 min, and finally in ecsicator for another 5 min. Rheological parameters were determined by rotational viscosimeter (Brookfield DV-III Ultra, USA), using supporting software Rheocalc.

3. Results and discussion

The aim of this investigation was to compose stable, concentrated Al_2O_3-t-ZrO_2 suspension, adequate for slip casting into plaster molds, which also implies reduced viscosity. The influence of added dispersant on zeta potential and rheological parameters was investigated.

Figure 1 shows the results of zeta potential measurements with different pH values, for suspensions with different amount of dispersant.

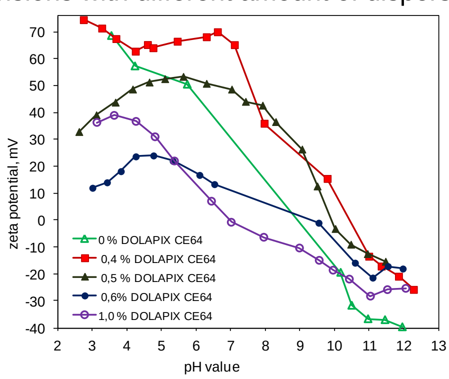

Figure 1. Dependence of zeta potential on pH values for 0,01 wt. % Al_2O_3-t-ZrO_2 suspensions.

Figure 1 shows that isoelectric point translated to the greater pH values for the 0,4 and 0,5 wt.% of dispersant, while for 0,6 and 1 wt.% of dispersant, it translated to the lower pH values. For the sample without dispersant (0 wt.%) the pH value couldn't be stabilized between 6 and 10. Other samples showed satisfying stability, which was confirmed with absolute values of zeta potential greater than 20 mV.

Rheological measurements were conducted on 60 wt.% Al_2O_3-t-ZrO_2 aqueous suspensions, containing 0,4 and 1 wt.% of DOLAPIX CE64. Obtained results are presented as:

- Dependence of apparent viscosity on the shear rate for suspensions with different amounts of DOLAPIX CE64 (Figure 2A),
- Dependence of shear stress on the shear rate for suspensions with different amounts of DOLAPIX CE64 (Figure 2B).

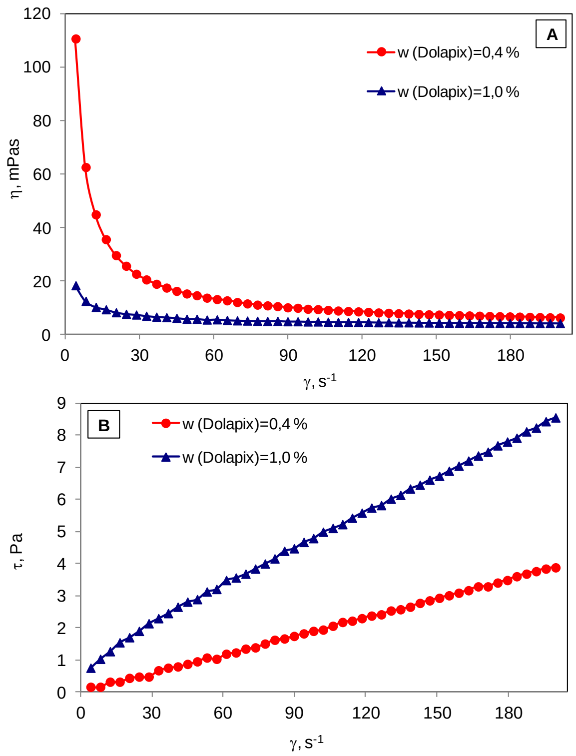

Figure 2. Flow curves for aqueous 60 wt. % Al_2O_3-t-ZrO_2 suspensions with different amounts of DOLAPIX CE64. (A) Dependence of apparent viscosity on shear rate. (B) Dependence of shear stress on shear rate.

Obtained flow curves for aqueous 60 wt. % Al_2O_3-t-ZrO_2 suspensions show typical pseudoplastic behavior, i.e. apparent viscosity decreases with the increasing shear rate. In order to evaluate experimental data, two mathematical models were used. These models are Power law and Herschel-Bulkley model and are usually used for pseudoplastic fluids [8-11]. Power law is useful for determining the following rheological parameters:

coefficient of consistency and flow index, while Herschel-Bulkley model can be used to determine yield shear stress. The mathematical form of the Power law is presented with Eq. (1), while the Herschel-Bulkley model is showed with Eq. (2).

$$\tau = k\gamma^n \tag{1}$$

$$\tau = \tau_0 + k\gamma^n \tag{2}$$

Where:
- τ (Pa) represents shear stress,
- k is a consistency coefficient,
- γ (s^{-1}) stands for shear rate,
- n is flow index (shear rate exponent),
- τ_0 stands for yield stress.

Obtained values of rheological parameters for used models are shown in Table 1. (aqueous 60 wt. % Al_2O_3-t-ZrO_2 suspensions; mass ratio Al_2O_3:t-ZrO_2 is 85:15).

Table 1. Rheological parameters for 60 wt.% Al_2O_3-t-ZrO_2 suspension, with different amounts of dispersant DOLAPIX CE64

wt. % of DOLAPIX CE64	Power law $\tau = k\gamma^n$			Herschel-Bulkley model $\tau = \tau_0 + k\gamma^n$			
	k	n	R^2	τ_0	k	n	R^2
0,4	22,47	0,32	95,7	0,37	25,6	0,67	99,1
1	2,01	0,92	92,7	0,01	0,93	1,07	99,7

Values of correlation coefficient (R^2) from Table 1 show that both applied models give good rheological parameters for investigated system. However, correlation coefficient for Herschel-Bulkley model is greater than the one for Power law, so it can be considered that Herschel-Bulkley model gives more accurate results. Flow index (n) of first sample (aqueous 60 wt. % Al_2O_3-t-ZrO_2 suspension with 0,4 wt.% of DOLAPIX CE64) is less than one for both models, which indicates pseudoplastic behavior of investigated suspensions. Flow index (n) from Herschel-Bulkley model for the sample with 1 wt.% of DOLAPIX CE64 is greater than one, which indicates dilatant behavior. Consistency coefficient (k) decreases with the increase of DOLAPIX CE64 amount in the suspension. Yield stress (τ_0) also decreases with the increasing amount of dispersant.

Measured apparent viscosity (η, mPa·s) for chosen shear rates (γ, s^{-1}) are shown in Table 2.

Table 2. Apparent viscosity (η, mPa·s) for chosen shear rates (γ, s^{-1}) in aqueous 60 wt.% Al_2O_3-t-ZrO_2 suspensions (mass ratio Al_2O_3:t-ZrO_2 is 85:15) for different amounts of DOLAPIX CE64.

wt.% of dry powder	wt.% of DOLAPIX CE64*	viscosity, η, mPa·s		
		shear stress, γ, 50 s^{-1}	shear stress, γ, 100 s^{-1}	shear stress, γ, 150 s^{-1}
60	0,4	15,36	9,51	7,47
	1	1,45	1,36	1,39

* the amount of DOLAPIX CE64 is based on the amount of used dry powder (Al_2O_3-t-ZrO_2 mixture)

It is evident that for the investigated system viscosity decreases with the increasing amount of dispersant DOLAPIX CE64. The shear rate of 50 s^{-1} is the shear rate of gravity slip casting. It is low enough for the suspension with 1 wt.% of DOLAPIX CE64 (1,45 mPa·s) so it can be established that this amount of investigated dispersant gives adequate rheological properties to the aqueous 60 wt.% Al_2O_3-t-ZrO_2 suspension (the mass ratio Al_2O_3:t-ZrO_2 is 85:15).

4. Conclusion

Dispersant DOLAPIX CE64 was used for stabilization of aqueous 60 wt.% Al_2O_3-t-ZrO_2 suspension. The stability of prepared suspensions was determined by measuring their zeta potential and rheological properties.

The results of zeta potential measurements on the 0,01 wt.% Al_2O_3-t-ZrO_2 suspensions showed the following:
- The isoelectric point translated to greater pH values for the 0,4% and 0,5% of dispersant, while for 0,6% and 1% of dispersant, it translated to the lower pH values,
- All samples containing the dispersant showed satisfying stability, which was confirmed with absolute values of zeta potential greater than 20 mV,
- For the sample without dispersant (0%) the pH value couldn't be stabilized between 6 and 10.

Obtained results of the rheological measurements for aqueous 60 wt.% Al_2O_3-t-ZrO_2 suspensions (the mass ratio Al_2O_3:t-ZrO_2 is 85:15) with 0,4 and 1 wt.% of dispersant showed the following:
- 60 wt.% suspension with 1 wt.% of DOLAPIX CE64 with shear rate of gravity slip casting (50 s^{-1}) reaches value of η=1,45 mPa·s,
- The increased amount of this dispersant lowers the viscosity of observed system.

Flow curves showed that investigated suspensions were pseudoplastic. For the estimation of the experimental data, two mathematical models were used: Power law and Herschel-Bulkley model. Obtained correlation coefficient (R^2) is somewhat higher for the Herschel-Bulkley model, so it can be established that this model gives better mathematical description of the researched system. All obtained data from the zeta potential measurements and rheological parameters determination showed that polyelectrolyte DOLAPIX CE64 is good and effective dispersant.

5. Acknowledgement

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EXPERIMENTAL STUDY OF ND:YAG LASER MACHINING OF CR-NI AUSTENITIC STAINLESS STEEL

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Abstract
Laser micromachining is a powerful process of creating new surfaces, structures, cavities and also complex electro-mechanical devices with very small dimensions by laser radiation. This process highly depends on choosing proper parameters and their settings. An experimental investigation of laser micromachining with low-power, diode-pumped Nd:YAG laser is presented in the paper. Material used in the experiment was austenitic Cr-Ni stainless steel type X5CrNi18-10 (1 mm thin metal sheet). The experiment was planned by Taguchi method and created cavities were evaluated by conventional optical and also confocal microscopy in order to achieve values of surface roughness and volume of removed material. It was demonstrated practically, that low-power laser is able to remove material from workpiece, and it was confirmed, that this process is crucially sensitive to input parameters settings.

Keywords:
laser, micromachining, stainless steel, Taguchi approach

1. Introduction

Laser micromachining presents the expression, which covers machining of components with dimensions below 1 mm [1] or it is expression for something, that is too small to be machined easily [2].

Laser micromachining specifically refers to drilling and cutting with intensive laser beam, usually in the form of pulse trains, with energy far exceeding the ablation threshold of the target material.

Different types of lasers are used for micromachining applications. CO_2, Nd:YAG and excimer lasers are mainly used for this purpouses [3]. Nd:YAG lasers were successfully applied for micromachining of ceramics [4], composites [5], semiconductors [6] and stainless steel. There are many studies about laser micromachining of stainless steel in which results of investigation how modification of input parameters can influence given outputs are presented. In some of them, possibility of using laser radiation from various sources for many applications, such as creating periodic structures on stainless steel [7], formation of self-organizing structures [8], biocompatibility and wettability of stainless steel after laser irradiation [9] and also possibility of creating cavities on the surface of stainless steel with aim of maximizing the volume of removed material was studied [10].

2. Experiment

The experiment was accomplished in International Laser Centre in Bratislava on low-power Nd:YAG laser (type Valentino made by AVANTEK Nové Mesto nad Váhom, Slovakia) with maximal 8 W of optical power, wavelength of radiation 1064 nm, working in pulse mode. The experimental setup (shown in the Figure1) also consists of laser optics (1), medium feed (2), plate of austenitic stainless steel type X5CrNi18-10 of 1 mm thickness (3) and 2D moveable, numerically controlled worktable (4).

The experimental layout using the Taguchi $L_{27}(3^{13})$ orthogonal array was used in this study. L_{27} array has a possibility to assess the main effects of three parameters and two factors interactions, too.

The influence of the optical power, position of focal spot, interaction time of laser with material and type of medium have been studied.

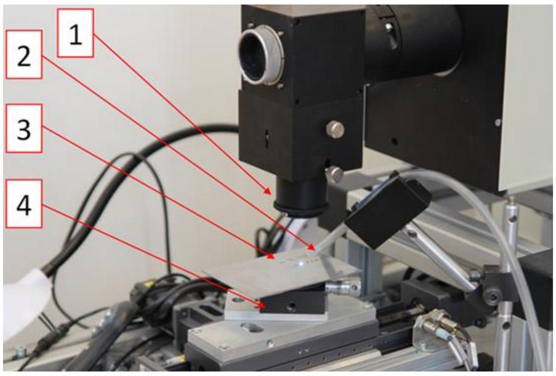


Figure 1. Experimental setup used for laser micromachining of austenitic steel

Input parameters and their levels are summarized in Table 1. The numbers -2, 0, 2 in the table represent focal spot position below,
on and above the surface of sample. Several constant parameters was also involved in this experiment, such as frequency (2000 Hz) and beam movement strategy (raster).

Table1. Parameters and their levels used in experiment

Parameter	Level		
	1	2	3
Optical power (W)	5	6,5	8
Interaction time (s)	0,05	0,1	0,15
Focal spot position (mm)	-2	0	2
Medium (-)	Air	O_2	Ar

Twenty seven new cavities (with square shape and 1,5 mm long sides) were created (on three samples, nine cavities on each one), respecting three different mediums used, by "raster" strategy of beam movement and combination of input parameters acquired by application of Taguchi method. Differences in interaction mechanisms were obvious during laser micromachining process due to different optical and also acoustical phenomenons presented.

3. Results

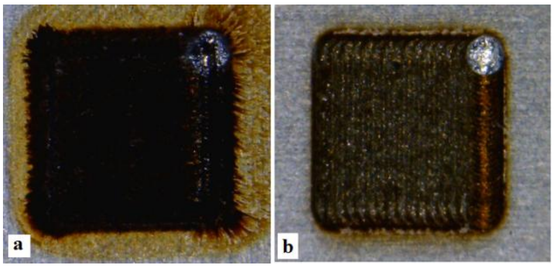
Although the target of experiment was to achieve minimum surface roughness and maximum volume of removed material, evaluation of experiment was getting complicated because of massive formation of oxides observed during micromachining process, so confocal microscopy was hard to use for surface roughness and volume of removed material determination andonly thirteen of twenty sevencreated cavities were evaluated. Measuredvalues are given in Tab. 2. It can be seen, that in three cases, the negative values of removed material (V) was measured. It means, that the volume of material below the surface sample was shy of volume of material above that surface, probably because laser power did not reach the level in which material could by removed and so, it was only re-melted. The highest value of removed material (Figure 2a) was reached with combination of parameters set to its highest values, position of laser focal spot on the surface of sample and in oxygen. The lowest surface roughness was observed on cavity (Figure 2b) made with 6,5 W of optical power. Interaction time was 0,05 s, focal spot was placed below surface of sample and air was used as a medium.

Table2.Surface roughness and volume of removed material

Experiment number	Ra (μm)	V ($10^{-3}.mm^3$)
1	11,90	- 82,5
2	7,74	59,6
7	1,07	-1,3
8	1,44	32,5
9	1,74	101,1
10	2,12	41,0
12	15,23	50,6
16	0,98	34,3
17	1,68	91,0
20	11,71	-27,9
21	4,44	189,1
25	1,61	52,4
27	9,86	118,3

Figure 2. Cavity made by micromachining of austenitic stainless steel (50x magnification)

a – sample with highest measured volume of removed material,



b – sample with minimum surface roughness 50x magnification

Measurement of cavity 21 by confocal microscope (Figure 3) showed, that material was removed up to 100 μm depth and solidified around borders of cavity up to 30 μm height. It is clear, that in this case, settings of input parameters led to conditions, in which material could be removed up to relative high depth.

Figure 3. The result of scanning of cavity 21 by confocal microscope

The morphology of surface of cavity 16 is shown in

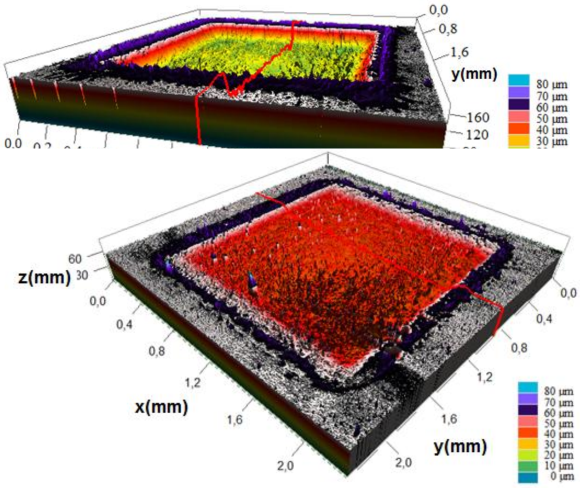


Figure 4. On some places, laser pulses removed material up to 15 μm and some volume of material was solidified around borders of cavity with maximum height about 5 microns.

Figure 4. *The surface morphology of cavity 16 obtained by confocal microscope*

The second highest value of removed material (about 33 percent lower than the highest one) was measured in cavity 27 (see Table 2). Input parameters were: 8 W (maximum) optical power, 0,15 s (the longest) interaction time, position of laser spot below the surface of sample and air as a medium.
The third highest value of removed material was found in cavity 9. Medium, interaction time, position of laser spot were the same as in previous case, but optical power was set to minimum (5 W) and about 15 percent lower value of removed material in comparison with previous cavity was found.
As it was already said, that minimum surface roughness was found in cavity 16, which was made by combination of medium values of input parameters and air. The next follows roughness measured in cavity 7, which was made in medium of argon, the lowest values of optical power and interaction time and in position of spot below the surface of sample, but in this case, material was not removed. Results obtained in presence of argon did not correspond with theoretical predictions. During micromachining process in this medium, formation of oxides was not eliminated in most of cases, but two cavities were found as oxides-free. Figure 5 shows cavity 7, which surface is almost oxides-free.
The Taguchi method allows to determine which input parameter influence given output the most together with possibility to choose parameters settings for achieving required output characteristics. Statistical methods led to finding, that in the case of maximization of volume of removed material, position of focal spot is the parameter, that influence it the most significantly. Then follows medium, interaction time and, finally, optical power.

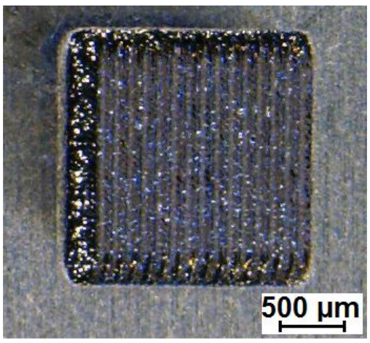


Figure 5. Oxides- free surface of cavity 7 obtained in presence of argon

Analogous method was used for minimization of surface roughness. It was shown, that in this case, the medium is the parameter with highest influence on the surface roughness. Subsequently follows position of focal spot, then interaction time and optical power.

4. Conclusion

The following conclusions have been drawn from this research:

- It was confirmed and demonstrated both process complexity of laser micromachining and also its sensitivity to choosing proper input parameters and their settings.
- It was shown, that experimental device used in this experiment (Nd:YAG low-power laser) is able to remove material from workpiece, but in other hand, parameters (and their values) used in experiment: frequency, wavelength, optical power, etc. significantly limited possibilities of maximizing volume of removed material. For higher volumes, more powerful laser device should be applied.
- Differences in interaction mechanisms could be seen during laser micromachining process, because of optical and also acoustical phenomenons taking part in process.
- It was also confirmed the presence of theoretically predicted mechanism of material removal, in which more melting and less evaporating of material was observed.
- There was observed massive formation of oxides in most cases, which complicated the evaluation of cavities by confocal microscopy. It was also used ultrasonic cleaner, but with minimum success.
- The best surfaces, from the viewpoint of pureness, were achieved in presence of argon, by which elimination of oxides formation was gained, but there was also observed exactly opposite process in given medium. It can be presumed, that different direction of gas flow could lead to different results. In our experiment, side flow was used.
- The Taguchi method appeared to be easy method for planning and evaluation of experiment.

5. Acknowledgement

The authors would like to acknowledge for financial support from the Ministry of Education, Science, Research and Sport of the Slovak Republic, project VEGA 1/0254/11.

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FORCE CALCULATION OF THE DEEP DRAWING PROCESS IN THE PRODUCTION OF THICK PLATE STEAM BOILER CAPS

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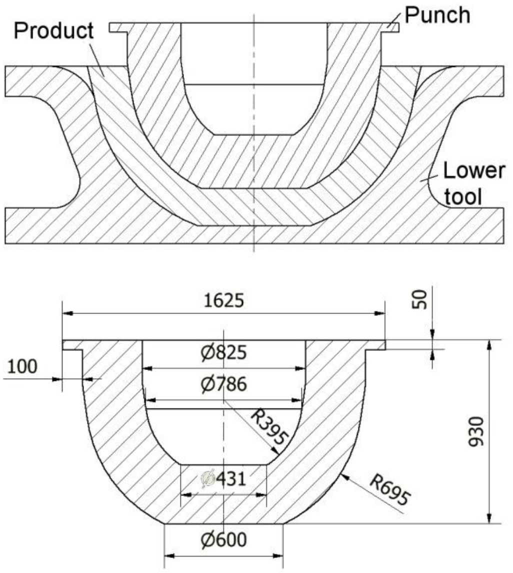
Abstract
In this paper the basics of a deep drawing process for the production of a thick plate steam boiler end caps are shown. Also the analysis of stresses which appear in the deep drawing process are shown – bending stress, frictional stress and inner stress due to displacement of material are also shown. Afterwards some mathematical formulations are made in order to find total stresses which appear in the material during the forming process which are needed for the force calculation.

Keywords:
Deep drawing, thick plate, steam boiler

1. Introduction

The production of thick plate steam boiler end caps is usually performed in one or more work travels on hydraulic presses. The designer of hydraulic presses and the engineer responsible for deep drawing of products should be aware of the amount of deep drawing force in the process.

So far, the empirical and theoretical expressions have shown to have very different results. In order to examine deep drawing forces which appear in the deep drawing process, a tool shown in Figure 1 was used.



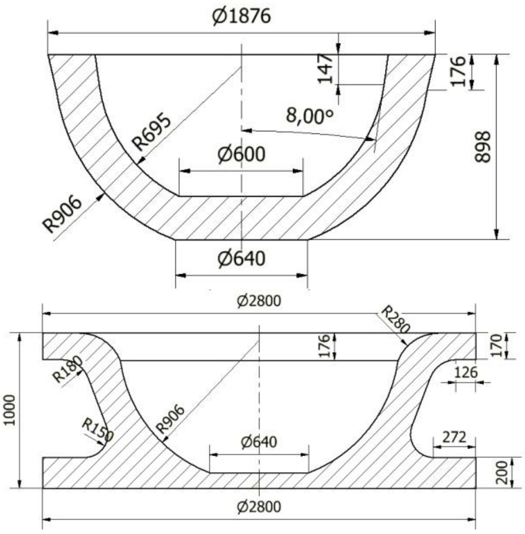


Figure 1. Experimental tool geometry and dimensions.

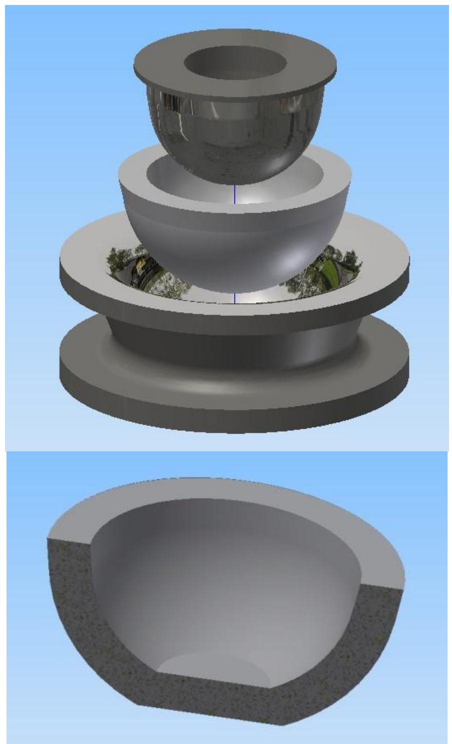


Figure 2. 3D model of experimental tool and deep drawn product.

Deep drawing process is performed in such a way that first a thick metal plate (dimensions 2180 mm in diameter and 210 mm thick) is heated-up to forming temperature, and then it is formed with tools under the pressure of hydraulic press.

2. Force calculation

In order to obtain the forming force needed for deep drawing process, it is necessary to understand which stresses act on infinitively small element which is shown in Figure 3 and Figure 4.

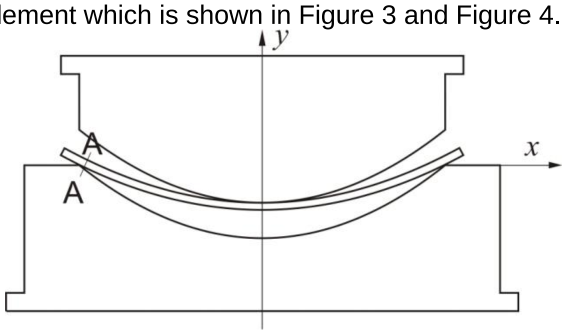


Figure 3. Schematic illustration of bending of plate with marked A-A section [1].

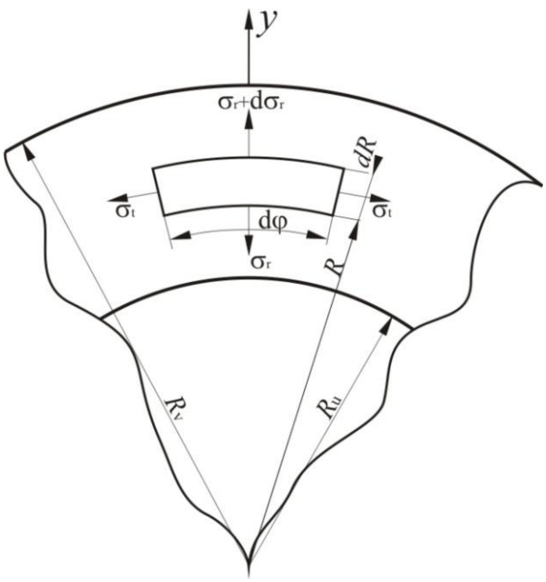


Figure 4. Stresses which act in marked section A-A form Figure 3. [1]

From Figure 3 it can be seen that section A-A is important for understanding stresses which act on the infinitive small element. This stresses are: plastic deformation stress $\sigma_{u,}$ stress form friction over the edge σ_{fr} and bending stress σ_{bend} [1].
Total stress is calculated as:

$$\sigma_{tot} = \sigma_u + \sigma_{fr} + \sigma_{bend} \tag{1}$$

In order to obtain stress of plastic deformation σ_u it is necessary to use infinitesimally small element and forces acting on it which can be seen if Figure 4 [1].

From the condition that all forces in *y* direction are in equilibrium it can be written that:

$$\begin{aligned}&(\sigma_r + d\sigma_r)(R + dR)s \cdot d\varphi - \\ &-\sigma_r \cdot R \cdot s \cdot d\varphi - 2\sigma_t \cdot \sin\left(\frac{d\varphi}{2}\right) \cdot s \cdot dR = 0\end{aligned} \tag{2}$$

Since expression $\sin\left(\frac{d\varphi}{2}\right) = \frac{d\varphi}{2}$ can be written for infinitesimally small angles and after dividing the expression (2) with thickness *s* it can be written [1]:

$$(\sigma_r + \sigma_t)dR + d\sigma_r \cdot R = 0 \tag{3}$$

In order to solve this differential equation (3) one additional expression must be introduced where k_f is forming stress:

$$k_f = \sigma_r + \sigma_t \tag{4}$$

After combining expressions (3) and (4) the solution of differential equation can be found as [1]:

$$\sigma_u = k_f \cdot \ln\left(\frac{R_v}{R_u}\right) \tag{5}$$

During the forming process, a plate is moving over the filleted edge with respective radius r_M and this plate needs to overcome the force of friction. This results in the larger stress near inner radius R_u which consists from bending and friction stresses.

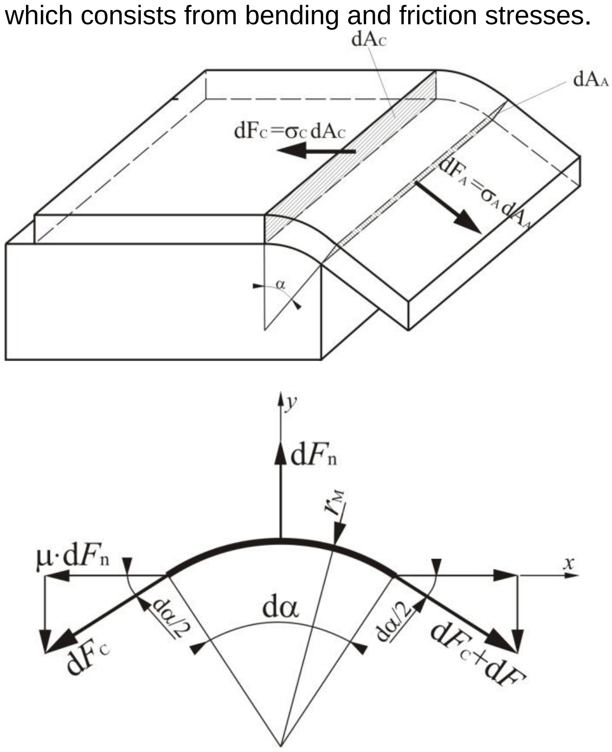


Figure 5. Schematic illustration of a plate moving over filleted edge of the tool and forces acting on the infinitesimally small element. [2]

If force dF_A increases for amount $dF=dF_A-dF_C$ there will be movement of sheet metal. By increasing the bending detail it can be shown that the forces which act on the bended surface looks like in Figure 5. Elementary band shown in Figure 5 has length $dl=r_M\cdot d\alpha$ [2].

From Figure 5, if all forces are set to be in equilibrium, and their values projected on x, and y axis, two equations can be written.

$$\sum X=0$$

$$\left(dF_C+dF\right)\cdot\cos\frac{1}{2}d\alpha-dF_C\cos\frac{1}{2}d\alpha-\mu dF_N=0 \tag{6}$$

$$\sum Y=0$$

$$dF_N-\left(dF_C+dF\right)\sin\frac{1}{2}d\alpha-dF_C\sin\frac{1}{2}d\alpha=0 \tag{7}$$

Since it can be written that:

$$\sin\frac{1}{2}d\alpha\approx\frac{1}{2}d\alpha \qquad \cos\left(\frac{d\alpha}{2}\right)\approx 1 \tag{8}$$

Expressions (6) and (7) can be written as:

$$dF-\mu dF_N=0 \tag{9}$$

$$dF_N-dF_C\cdot d\alpha=0 \tag{10}$$

When this two equations are combined it follows that:

$$dF=\mu dF_C\cdot d\alpha \tag{11}$$

Total accession of force for the finite bending angle can be written as:

$$\int_{dF_C}^{dF_A}\frac{dF}{dF_C}=\mu\int_0^{\alpha}d\alpha \tag{12}$$

By integration of expression (12) it can be seen that the force of friction for one volumetric element at the end of the arc can be written as:

$$\Delta F=dF_A-dF_C=dF_C\left(e^{\mu\alpha}-1\right) \tag{13}$$

Then it can be written that:

$$\sigma_{fr}=\frac{\Delta F}{\Delta A},\ \text{MPa}$$
$$\sigma_{fr}=\sigma_u\left(e^{\mu\alpha}-1\right),\ \text{MPa} \tag{14}$$
$$\sigma_{fr}=k_f\cdot\ln\left(\frac{R_v}{R_u}\right)\left(e^{\mu\alpha}-1\right),\ \text{MPa}$$

Bending stresses in the steam boiler cap will be positive in the outer tensile zone, and negative in the inner compressive zone in front of neutral plane.

This stress will increase with the thickness of the plate, and it will decrease with larger radius r_M.

Bending stress can be calculated with the following expression [2]

$$\sigma_{bend}=k_f\cdot\frac{s}{4r_M},\ \text{MPa} \tag{15}$$

This, combined with the expressions (1,5,12) leads to the following expression used for the calculation of total stresses in the material during forming [2]:

$$\sigma_{tot}=k_f\left(\ln\left(\frac{R_v}{R_u}\right)\cdot e^{\mu\alpha}+\frac{s}{4r_M}\right),\ \text{MPa} \tag{16}$$

Since total stresses are known, the forming force can be calculated with the following expression:

$$F_{tot}=A_A\cdot\sigma_{uk},\ \text{N}$$
$$F_{tot}=2\cdot R_v\cdot\pi\cdot s\cdot k_f\left(\ln\left(\frac{R_v}{R_u}\right)\cdot e^{\mu\alpha}+\frac{s}{4\cdot r_M}\right) \tag{17}$$

There are several more expressions with which the forming force can be calculated and for the purposes of this work only two of them will be mentioned.

The expression for calculation of forming force according to DIN norm [3]:

$$F_{tot}=2\cdot R_u\cdot\pi\cdot s\cdot R_m\left(\frac{R_v}{R_u}-b\right),\ \text{N} \tag{18}$$
$$b=0,6\ \rightarrow\ \text{coefficient}$$

And the expression for the calculation of forming force according to Tomlenov [3]:

$$F_{tot}=\left(1,5\div 2\right)R_m\cdot\ln\left(\frac{R_v}{R_u}\right)\cdot\pi\cdot R_u\cdot s,\ \text{N} \tag{19}$$

According to Siebel's expression, the forming force can be calculated as [3]:

$$F_{uk}=1,3\cdot\pi\cdot R_v\cdot s\cdot R_m\cdot\ln\left(\frac{R_v}{R_u}\right),\ \text{N} \tag{20}$$

3. Experiment

For the experiment, a steel plate of 2800 mm in diameter and 210 mm of thickness was used. During the forming plate was coated with graphite mixed with mineral oil. The temperature of heating of a steel plate was 1100°C and by the time the steel plate was mounted on the tool the temperature has dropped to 1040°C.

At the end of the forming process the temperature of the steel plate was 920°C.

The time needed for the plate to be extracted from the furnace and until the end of the forming process was 10-13 minutes. The forming process was performed in the 50 MN forming hydraulic press. In the production a 23 steam boiler caps were made, and maximal forming force was 28,6 MN.

Maximal difference of forming force in the production of 23 boiler caps was 2 MN.

Since material was heated to the medium temperature of 970°C, the forming stress and the tensile stress were assessed to 76 MPa according to the manufacturer data.

With the above mentioned data, and the use of Figure 1 (from which R_u = 695 mm, R_v = 906 mm), the forming force F_{tot} can be calculated.

From (17):

$$F_{tot} = 2 \cdot 906 \cdot \pi \cdot 210 \cdot 76 \left(\ln\left(\frac{906}{695}\right) \cdot e^{0,2 \cdot 1,57} + \frac{210}{4 \cdot 280} \right)$$

$$F_{tot} = 50022389 \text{ N} \approx 50 \text{ MN}$$

From (18):

$$F_{tot} = 2 \cdot 695 \cdot \pi \cdot 210 \cdot 76 \left(\frac{906}{695} - 0,6 \right) = 49037842 \text{ N}$$

$$F_{tot} \approx 49 \text{ MN}$$

From (19):

$$F_{tot} = 2 \cdot 76 \cdot \ln\left(\frac{906}{695}\right) \cdot \pi \cdot 695 \cdot 210 = 18477886 \text{ N}$$

$$F_{tot} \approx 18,5 \text{ MN}$$

From (20):

$$F_{tot} = 1,3 \cdot \pi \cdot 2 \cdot 906 \cdot 210 \cdot 76 \cdot \ln\left(\frac{906}{695}\right) = 31314033 \text{ N}$$

$$F_{tot} \approx 31,3 \text{ MN}$$

4. Conclusion

In this paper the basics of a deep drawing process for the production of a thick plate steam boiler end caps are shown. Theoretical analysis of stresses which appear in the deep drawing process are shown – bending stress, frictional stress and inner stress due to displacement of material are shown.

These stresses are described, and some mathematical formulations are made in order to find total stresses which appear in the material during the forming process.

Later the expression for the calculation of the forming force is shown. Also some other experimental formulations from the literature are presented.

These expressions were used for the calculation of the deep drawing force, and later the results were compared to the experimentally obtained force values in the production of boiler end caps.

The results show that the closest amount of force can be calculated with the expression (20). The difference in the results is from large amount of assumptions and simplifications used in the formulation.

Also some other forces exists in the forming process, and stresses which are caused by this forces needs to be further investigated by Finite Element Methods – FEM in order to better understand the deep drawing process.

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MORPHOLOGY OF NANOSTRUCTURED SOL–GEL TiO_2 FILMS ON STAINLESS STEEL

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Abstract
Titania (TiO_2) thin films with one-layer and three-layer were deposited on the X5CrNi18-10 (AISI 304) stainless steel by dip coating sol-gel process. For the preparation of sol, titanium isopropoxide was used as a precursor, propanol as a solvent, with addition of nitric acid as a catalyst and acetylacetone for peptization. Deposited films were calcined at the temperature of 550 °C. Scanning electron microscopy (SEM) equipped with EDS detector and atomic force microscopy (AFM) were used for characterization of prepared films. SEM-EDX analysis confirmed the TiO_2 films formation. Results obtained by AFM analysis show that the number of deposited layers influenced the surface topography, as well as roughness parameters.

Keywords: TiO_2 thin film, AFM, SEM-EDX.

1. Introduction

Ceramics are, in general, more resistant than metals to corrosion, erosion, oxidation and wear in high temperature environments [1, 2]. They also possess very good electrical insulation properties. Ceramics oxide films and coatings like TiO_2, Al_2O_3, ZrO_2, and SiO_2 etc. can be deposited on metals to improve their surface properties. There are several techniques for the deposition of films and coatings on metals, such as chemical vapor deposition (CVD), physical vapor deposition (PVD), plasma spraying, electrochemical deposition and sol–gel process. The sol-gel process, also known as chemical solution deposition, is a wet-chemical technique, a process involving following steps: hydrolysis and polycondensation, gelation, aging, drying, densification and crystallization. A sol-gel coating can be applied to a metal substrate through various techniques, such as dip-coating, spin-coating, spraying and electrodeposition [3]. The most important advantages of the sol-gel process are: low equipment costs, low processing temperature, good homogeneity, the usage of compounds that do not introduce impurities into the end product as initial substances, making it a "green", waste-free technology. These advantages make the sol-gel process one of the most appropriate technologies for preparation of thin, nanostructured films [4-9]. The aim of this work is to prepare thin, compact, nanostructured and homogeneous TiO_2 films by dip-coating technique. The morphology and composition of the films were determined by SEM-EDA and AFM analysis.

2. Method

Two steel plates (10×10×2 mm) were used as substrates. Chemical composition of X5CrNi18-10 (AISI 304) stainless steel was determined by glow discharge optical emission spectroscopy (GDS 850A, Leco) and results in wt. % were: C-0,06; P-0,037; S-0,006; Si-0,38; Mn-1,18; Cu-0,32; Mo-0,16; Cr-17,9; Ni-7,76 and Fe – the rest.

Before the deposition of films, steel substrates were ground with SiC abrasive discs (180-1000 grit) and then polished with diamond paste (3 μm and 0,25 μm). Substrates were then ultrasonically cleaned in acetone and subsequently dried.

For the preparation of sol, the following components were used:

- 5 ml titanium (IV) isopropoxide ($Ti(C_3H_5O_{12})_4$, Mr = 284,25, as a precursor,
- 44 ml i-propanol (C_3H_7OH), Mr = 60,1 as a solvent,
- 0,5 ml 0,5 mol/L nitric acid (HNO_3), Mr = 63,01, as a catalyst,
- 1,1 ml acetylacetone ($CH_3(CO)CH_2(CO)CH_3$), Mr = 100,12, for peptization.

Sol was prepared by dissolving titanium isopropoxide in i-propanol. A magnetic stirrer was used for continuous stirring. Nitric acid and acetylacetone were added successively. The first and second stainless steel plates were dipped one and three times, respectively, into sol by a homemade, electrically driven pulley system, simultaneously. Steel substrates were dipped into sol at a rate of 10 mm/min, then were held in solutions for 3 minutes in order to allow surface wetting. The withdrawal speed was also 10 mm/min. After each dip, the steel substrates had been dried at room temperature for 10 minutes. Subsequently, each steel substrate was dried at 100 °C for an hour. After dip-coating and drying, each steel substrate was calcined at 550 °C for 4 hours.

The morphology and chemical compositions of the TiO_2 films on steel substrates were determined by means of the scanning electron microscopy (Tescan Vega TS5136LS) equipped with the EDS detector. The surface topography of the TiO_2 films was determined by the Multimode AFM with a

Nanoscope IIIa controller (Veeco Instruments, Santa Barbara, CA), under ambient conditions in air. Roughness analysis option was used to perform roughness analyses on 0,5 μm × 0,5 μm imaged surface area for each sol-gel TiO_2 film. Results are presented as R_a, R_q, R_z, R_{max} and Z range values.

3. Results and discussion

Figs. 1A and 1B show surface morphology of TiO_2 with single-layer and three-layer obtained by SEM analyses, while Figs. 1C and 1D represent their corresponding EDX spectra.

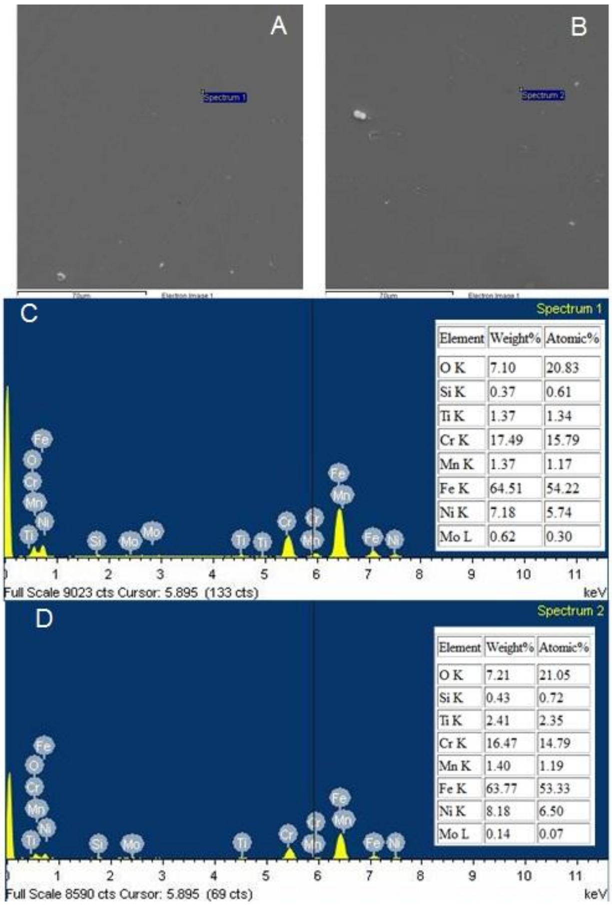


Figure 1. (A) SEM images of the surfaces of sol-gel TiO_2 film with single-layer, (B) SEM images of the surfaces of sol-gel TiO_2 film with three-layers; (C) EDX measurements of TiO_2 film with single-layer and (D) EDX measurements of TiO_2 film with three-layers.

It is clear that the obtained films were free from the cracks and pinholes (Figs. 1A and 1B). Results of EDX spectra of the surface of TiO_2 film with single-layer and three-layers (Figs. 2C and 2D) confirmed the TiO_2 films formation.

The AFM (atomic force microscopy) analysis shows the surface morphology of TiO_2 films with single-layer and three-layers. Figs. 2A and 2B show 3D views of height data and the characteristic vertical profiles ("section analysis") of TiO_2 film with a single-layer and three-layers.

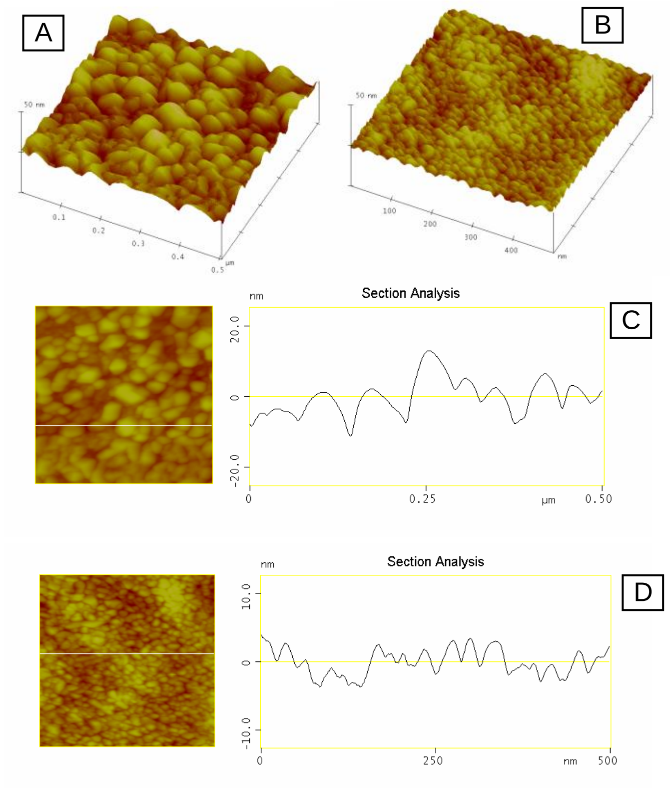


Figure 2. AFM analysis of TiO_2 film with single-layer and three-layers. Surface topography is presented as 3D-views of height data and as a height profile along indicated lines ("section analysis"). (A) Surface topography and (C) corresponding section analysis of a single-layer TiO_2 coating. (B) Surface topography and (D) corresponding section analysis of a three-layer TiO_2 coating.

As shown in Figs. 2A and 2B, the coatings reveal a homogeneous, granular surface.

For both TiO_2 films following roughness parameters were determined: R_a, R_q, R_z, R_{max} and Z range values.

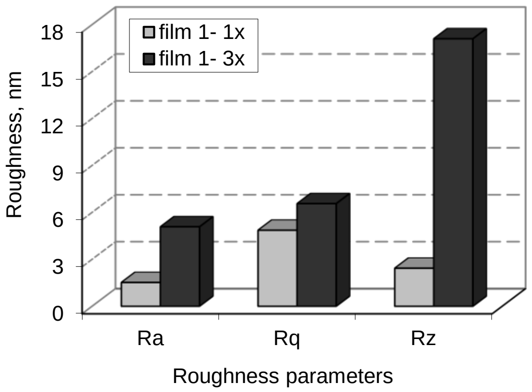
R_a is the arithmetic average of absolute values of the surface height deviations measured from the mean plane:

$$R_a = \frac{1}{N\sum_{j=1}^{N}|Z_j|} \tag{1}$$

R_{ms} is the root mean square average of height deviations taken from the mean data plane:

$$R_{ms}(R_q) = \sqrt{\frac{\sum (Z_i)^2}{N}} \tag{2}$$

R_z is the average difference in height between five highest peaks and five lowest valleys relative to the mean plane, while the *Z* range is the maximum vertical distance between the highest and lowest data point within the analyzed region and the mean plane is the plane for which the summation of the square of distances from all points on the true profile to the plane is a minimum.
The roughness parameters of both TiO_2 films are presented in Figure 3.



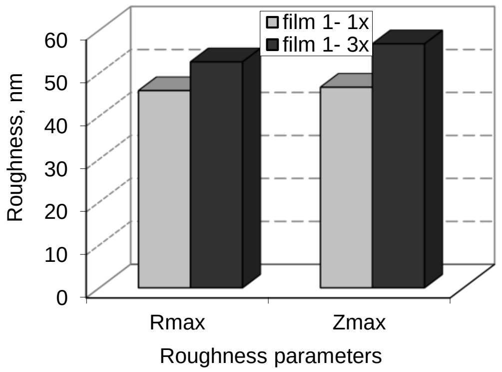


Figure 3. The roughness parameters of TiO_2 films with single-layer and three-layers.

All determined roughness parameters increase with the increasing number of layers (Figure 3).

4. Conclusion

Uniform TiO_2 films were successfully prepared on stainless steel substrates using a sol-gel method and dip-coating technique. The results of AFM analyses of prepared films confirmed the presence of nanostructured sol-gel TiO_2 coatings on stainless steel substrates. It was also confirmed that the surface was compact, without the presence of cracks. The increase in the number of layers caused the increase in roughness parameters.

5. Acknowledgement

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FLEXIBLE ASSEMBLY CELL PRODUCTION PROCESS OPTIMIZATION

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Abstract
Paper deals about flexible assembly cell analyze by graph and network theory and application selected methods. The introduction describes the basic characteristics of approaching the issue. The aim is to analyze the spatial analysis prototype flexible assembly cell, its description and the description of the activities of individual sections and methods of network analysis application.

Keywords:
Assembly cell, Lawler's algorithm, optimization

1. Introduction

The analyzed device consist of 3-axis shelf storage and 3 axis Cartesian robot, rotating unit, clamping fixture, spring magazine and cover magazine. (Figure1.). Shelf storage provides storage of semiproducts, individual components and final products too. These components and products are placed on pallets. One of the shelf manipulator tasks is select and pull pallet with required component from storage and place to rotating units. Rotating unit is an interface between shelf storage and assembly cell. This rotating unit provides inputs and outputs in and out from assembly cell workspace. Assembly process is performed by 3-axis Cartesian robot with automation gripper change system. Clamping fixture is one of the parts of assembly cell placed in working plate of Cartesian robot. This fixture allows perform continual rotational movement required speed and direction as lathe chuck. Clamping fixture allows workpiece accurate positioning in their vertical axis too. Flexible assembly cell control is provided by industrial computer. Electric and pneumatic energy are used to device operations. Assembly cell products are 3 type of linear pneumatic motors. (Figure 2.).

Five manufacturing operations are integrated on flexible assembly cell. There are:

- Semiproducts storage and transportation for production device,
- Individual parts manipulation,
- Assembly to final product,
- Final products manipulation and storage before expedition.

Each product passes all these operations during their manufacture. [4]

Figure 1. Flexible assembly cell with shelf storage.

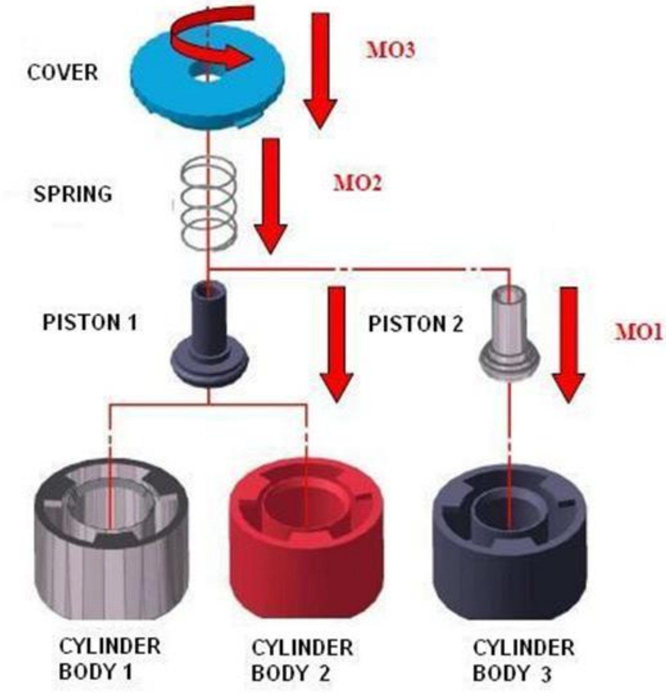

Figure 2. Assembly procedures graph of linear pneumatic motor.

2. Lawler algorithm application to manufacturing process optimization

This algorithm calculates an optimal schedule of jobs to be processed on a single machine (in reversed order) while taking into consideration any precedence constraints. (Figure 3). [1]

Two preconditions must satisfy solved problem. There are:
1, Predetermined manufacturing operations with technological or technical follow-up.
2, Weight preferences w_j presents individual operations significance – the higher weight value, the higher the preference of the operation.
Procedure:
1. Given i = 1 and calculate the total processing time of all operations, time of the last operation the value is

$$o_j = \sum_{j=1}^{n} t_j \tag{1}$$

2. Given G be a set of those operations can be performed as the last, without a break of the technological and technical follow-up. These operations are assigned a value of
$\max\{\ f^i - d_{j,} 0\ \}$
Choose operation ok from set G, for which an
min (w_j max $\{f^i - d_j$,0}) .
This operation is performed as a last and is omitted from the set G.
Determine the value

$$f^{i+1} = f^i - t_k \tag{2}$$

3. Given i = i + 1 and repeat step 2 to determine last manufacturing step, which will be made the first. [2]

	o_j	o_1	o_2	...	...	...	o_n	Rozvrhnuté
	t_j	t_1	t_2	...	...	...	t_n	operácie
	d_j	d_1	d_2	...	...	...	d_n	o_j
f^i	w_j	w_1	w_2	...	...	...	w_n	
f^1		m_1^1	m_2^1	...	...	...	m_n^1	
f^2		m_1^2	m_2^2	...	...	...	m_n^2	
...		...	...	...	...	...	...	
...		...	...	...	...	...	...	
...		...	...	...	...	...	...	
f^n		m_1^n	m_2^n	...	...	...	m_n^n	

Figure 3. Application of Lawler's algorithm [3]

Symbols used in figure 3:

…	if o_j can not be implemented
$\{m_j^i\}$ = w_j max $\{f_i - d_j$, 0}	if o_j can be implemented
X	if o_j has already been implemented

Assembly procedures graph shows first part on storage and assembly cell is cylinder. The next one is piston.
Indicated individual components as follows:

Cylinder body 3 - 0_1
Piston 2 - 0_2
Cylinder body 2 - 0_3
Piston 1 - 0_4
Cylinder body 1 - 0_5
Piston 1 - 0_6.

It follows:
Operations that can go first: 0_1 , 0_3, 0_5.
Operations that must be the last : 0_2, 0_4, 0_6.

Table 1. Data for individual operations

O	O_1	O_2	O_3	O_4	O_5	O_6
t_j	2	3	4	3	4	5
d_j	3	5	6	7	6	6
w_j	3	3	2	2	2	3
Previous operation	.	O_1	.	O_3	.	O_5
f^1=21	.	48	.	28	.	45
f^2=21	.	39	24	X	.	36
f^3=21	.	27	X	X	.	24
f^4=21	.	12	X	X	6	X
f^5=21	.	0	X	X	X	X
f^6=21	O	X	X	X	X	X

O – operation
t_j– operation time
w_j– max. operations time
d_j– weight preferences
f^1= Σt_j = 21

$$f^{\,i} = f^{i-1} - tj \tag{3}$$

Table number 1 calculation :
1. Calculation step
Operation 0_2 => 3(21-5) = 48
Operation 0_4=> 2(21-7) = 28
Operation 0_6 => 3(21-6) = 48

2. Calculation step
Operation 0_2 => 3(18-5) = 39
Operation 0_3 => 2(18-6) = 24
Operation 0_6 => 3(18-6) = 36

3. Calculation step
Operation 0_2 => 3(14-5) = 27
Operation 0_6 => 3(14-6) = 24

4. Calculation step
Operation 0_2 => 3(9-5) = 12
Operation 0_5=> 2(9-6) = 6

5. Calculation step
Operation 0_2=> 3(5-5) = 0

6. Calculation step
Operation 0_1 => 3(2-3) = -1; 0

Consider the following notation
min [(w_j max{$f^i - d_j$,0})]
The resulting sequence of operations will then be
0_1 - 0_2
0_5 – 0_6
0_3 – 0_4.

3. Conclusion

The entire material flow analysis of a flexible assembly cell was developed to highlight the developments in production, leading to so-called. individualization of consumer strategy. What is a quick response manufacturing a wide range of products in smaller doses. It is important to set the parameters to be monitored to achieve a flexible response system to changes in production requirements as well as changes in their surroundings.

4. Acknowledgement

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MULTY-BODY DYNAMIC SIMULATION OF LARGE IC ENGINE CONNECTING ROD

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Abstract
The transmission of power in IC engines are from combustion in cylinders to piston and piston pin via the connecting rod to the crankshaft which is achieved by the fluid film lubrication in the bearings. The force applied to the connecting rod is dependent on the pressure distribution in the lubricant film and by the stiffness of the connecting rod. From that conclusion, the dynamic behavior of the connecting rod is crucial for structural design. Dynamic behavior include elastohydrodynamic lubrication in bearings. In this paper, large medium speed IC engine simplified connecting rod will be analysed by modern multy-body dynamic simulation in software AVL Excite 2010.1 [1]. Elastohydrodynamic behavior of big end bearing will be evaluated. Substructuring of finite element model was done in software Abaqus 6.10 [2].

Keywords:
Connecting rod dynamics, elastohydrodynamic lubrication, multy-body dynamic simulation

1. Introduction

Reciprocating machines are provided with crank mechanisms to transform the reciprocating motion of the pistons into the rotating motion of the crankshaft. The connecting rod connects the piston to the crankshaft, and consists of the crank or big end, pin or small end, and shank [3]. The crank pin is eccentric to the rotational axis of the crankshaft, resulting in a moment force that induces a rotary motion, as shown in figure 1 [3].

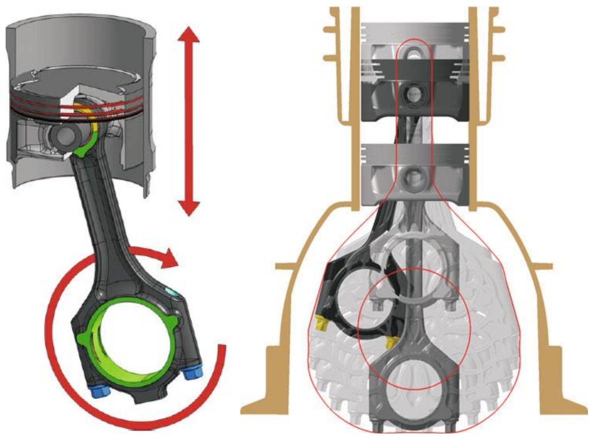

Figure 1. Motions of connecting rod [3]

Pistons, piston pins, connecting rods, crankshaft and flywheel all together form a reciprocating piston engines crankshaft assembly. The components of the crankshaft assembly are subject to high gas forces and to high inertia forces. Conflicting demands such as minimum mass on the one hand and high stiffness and fatigue strength on the other present a challenge to structural design. Knowledge of fatigue limits of materials, notch factors, heat treatments, surface roughness, dispersion ranges, size factors and influence factors in way of mean stresses are crucial for estimation of high-cycle fatigue strength. Piston mass contributes substantially to the oscillating mass and is thus subject to strict criteria of lightweight construction. Combustion chamber pressure and temperature highly stress a piston thermomechanically. Highly thermally conductive aluminium piston combine low density with high thermal load relief. However, their use in diesel engines reaches it's limits at firing pressures above 200 bar. In principle, steadily increasing ignition and injection pressures result in ‘‘harsher’’ combustion. This creates problems with acoustics. Averaged peak firing pressure in modern medium speed engines are approximately 210 bar [4]. Medium speed engines are used for ship propulsion, trains, tanks, generation sets for power generation, etc. Figure 2 shows example of modern medium speed IC engine.

Figure 2. Large medium speed IC engine MAN Diesel 48/60CR [4]

2. Dynamic model of connecting rod

The gas force and oscillating inertia force load a diesel engines connecting rod shank with pulsating compressive stress. Inertia force generates pulsating tensile and bending stress in the connecting rod small end. The oscillating inertia force from the piston and connecting rod minus that of the connecting rod bearing cap acts on the connecting rod small end. The bolted connecting rod joint produces static compressive prestress in the clamped area. The shrink fit of the small end bushing and the big end bearing causes static stresses. Figure 3 shows deformation of connecting rod under gas and inertia force.

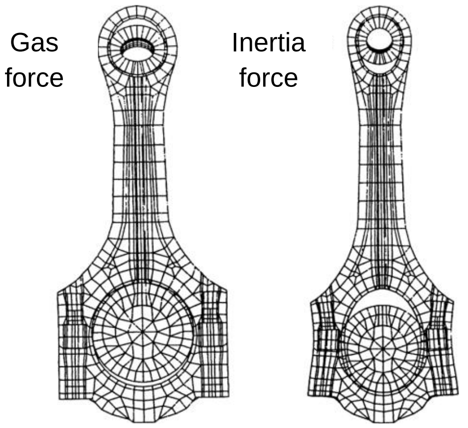

Figure 3. Deformation of connecting rod under gas and inertia force [5]

Simulating every effect (deformation of the bearing, bushing, crankshaft and connection rod, bearing clearances, hydrodynamic lubricating film formation with supply pressure, temperature and dynamic viscosity) proves difficulty and complexity of dynamic simulation. The joint integrity between the connecting rod and the cap is provided by the bolts. The connecting rod big end bore ovalizes under inertia force and the bolts are bent outwards. If the bolt force is insufficient, the connecting rod bolted joint will open towards the crank journal pin side, as shown in figure 4 [3].

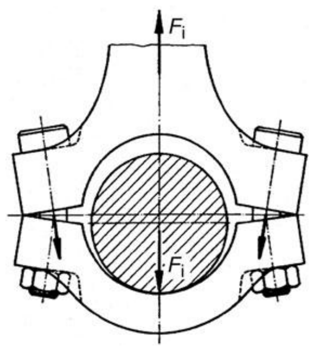

Figure 4. Bolts bending and gap opening caused by inertia force [3]

3. Elastohydrodynamic lubrication and plain bearings

Most of the human body's joints are diarthrodial, which means their articulation is freely movable. In a diarthrodial joint, the contiguous bony surfaces are covered with articular cartilage, and connected by ligaments lined by a synovial membrane (Gray and Lewis, 1918). Figure 5 shows typical diarthroidal joint in human body.

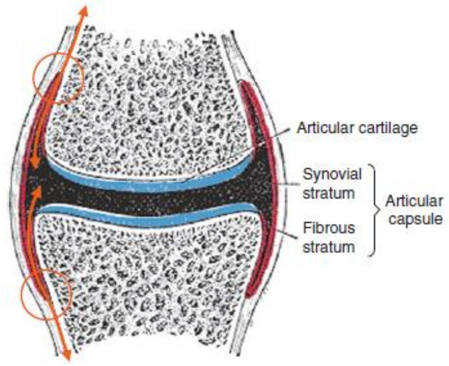

Figure 5. Typical diarthrodial joint [6]

Plain bearings in IC engines function according to the principle of hydrodynamics. Fluid film bearings operating in the full hydrodynamic regime support the load on a very thin film. The pressure field produced acts as a spring force. In addition to its rotary motion, the load causes the shaft to execute movements with a radial component. This squeezes the lubricant out of the gap in circumferential and in axial directions. Produced pressure field acts as a damping force. The pressure field from rotation and displacement superimpose on each other, thus generated the bearing reaction force that separates the sliding surfaces of the shaft and bearing. Figure 6 shows pressure field in plain bearing. The basis for the simulation of hydrodynamics in plain bearings is the Reynolds differential equation which describes the lubricant flow in the lubricating gap by simulating motion (Navier-Stoke's equation) linked with the condition of continuity.

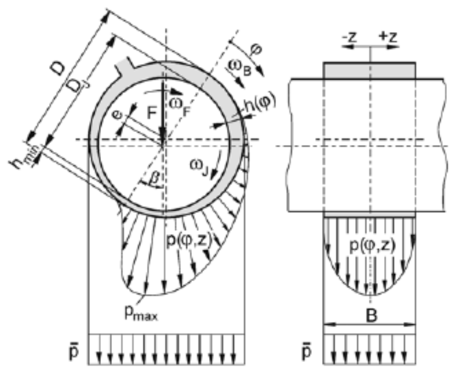

Figure 6. Pressure field in plain bearing [7]

Due to very complex elastohydrodynamic behavior of plain bearings, the shell profile of big end bearing usually have elliptical cross-section. Very often usage for connecting rod big end bearing are lemon shape bearings, which not allow metal to metal contact and whirl instability. Figure 7 shows elliptical bearings.

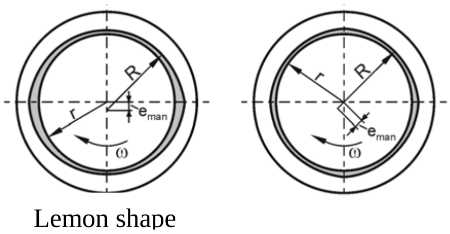

Figure 7. Elliptical bearings [7]

From the standpoint of rotordynamics, the main advantage of fluid film bearings is their inherent damping characteristics [8].

4. Multi-body dynamic simulation

A multy-body dynamic simulation (MBS) is used to model the dynamic behavior of interconnected elastic bodies (which can have large translational and rotational displacement) connected with nonlinear joints. Connecting rod in this paper have simplified geometry for large IC medium speed diesel engine, due to fact that just will show modern application of numerical simulation in very complex systems. Connecting rod height is 1000 mm. Geometry was created with finite element mesh in software SimLab 9.0 [9]. In SimLab, geometrical bodies are created automatically with FE mesh. Big end bearing have width of 110 mm and diameter of 266 mm. Piston mass is 110 kg. Bore and stroke are 350 and 500 mm, respectively. From [3] recommended starting value for bearing diametric clearance is 0,1 % of bearing diameter, and from that conclusion the radial clearance used in simulation is 133 microns. Selected firing pressure is in range for modern diesel medium speed engines with peak firing pressure of 210 bar, from [4]. Oil dynamic viscosity is 0,03 Pa·s with supply pressure of 3 bar. Piston mass, bore and stroke are selected from catalogs of manufacturers in way of taking typical numbers. From [4], the typical engine speeds for medium speed engines are between 300 and 1000 rpm. Selected speed is 500 rpm.

After FE mesh preparation, the substructuring of selected nodes was done in software Abaqus 6.10 [2]. Substructured nodes are on big end bearing surface, center of small end, and for axial joints (i. e., springs) to hold model in space. Multy-body dynamic simulation is done in software AVL Excite 2010.1 [1]. Limit values for maximum loads and minimum oil film thickness for connecting rod bearings and main bearings of cars, trucks and large diesel engines can be viewed in [10].

5. Results

First results are the forces in big and small end, in figures 8 and 9. Red curve represent vertical force component, and blue curve represent horizontal force component. All results are for 720° crankshaft rotation in second cycle (720 – 1440°). Forces in polar diagrams are shown in figures 10 and 11. Max value is close to 200 kN.

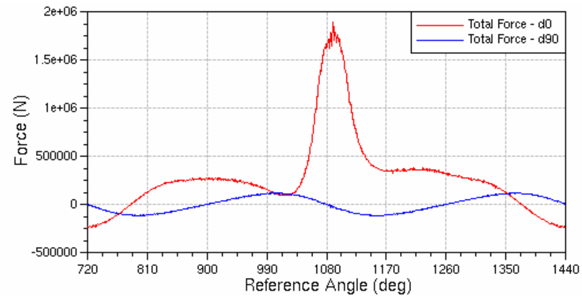

Figure 8. Big end forces

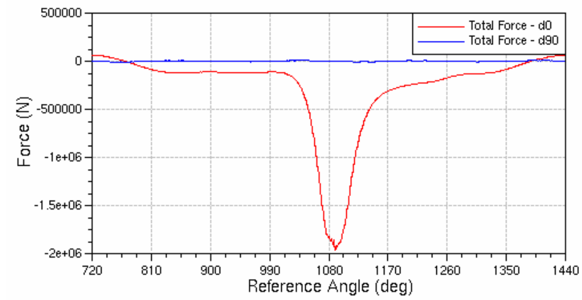

Figure 9. Small end forces

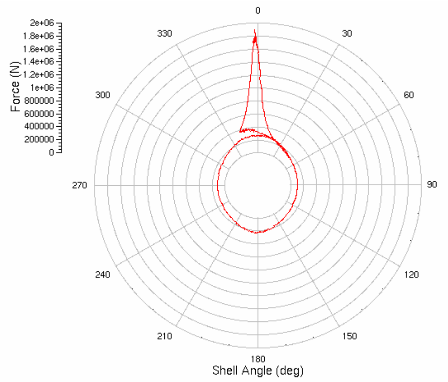

Figure 10. Big end force (polar)

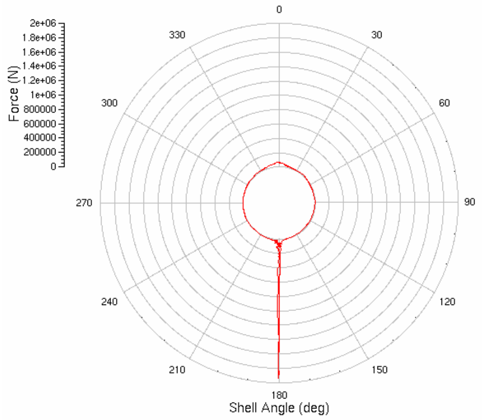

Figure 11. Small end force (polar)

Next results are related to big end bearing. Peak total pressure is shown in figure 12. From results can be concluded that highest peak total pressure of 180 MPa is when the gas load is applied. In figure 13 minimum oil film thickness is shown, which have minimum value of 1 micron when the gas load is applied.

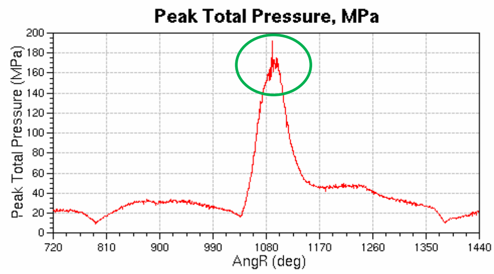

Figure 12. Peak total pressure in big end

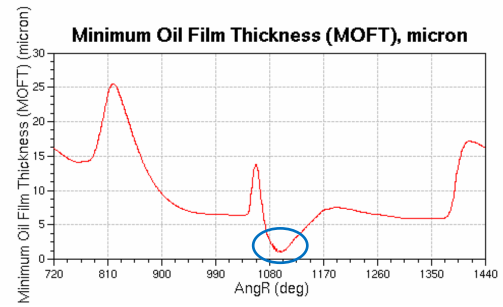

Figure 13. Minimum oil film thickness in big end

2D results shows over shell angle and bearing width local extremum of pressures. In figure 14 are shown hydrodynamic pressures, and in figure 15 asperity contact pressure which are vely low for big end fluid film bearing.

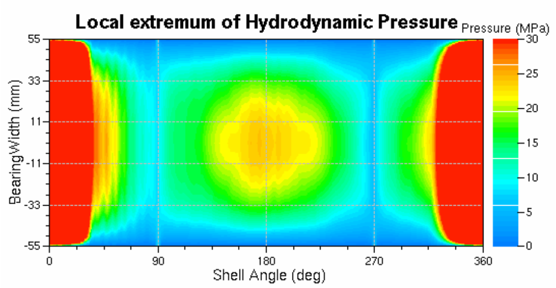

Figure 14. 2D results of hydrodynamic pressure

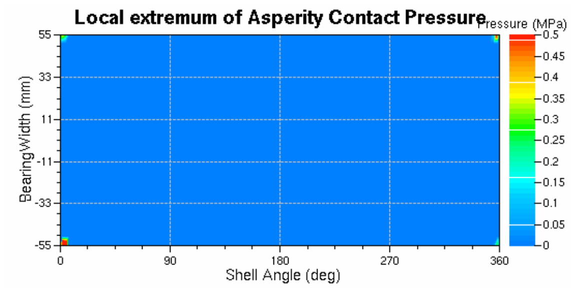

Figure 15. 2D results of asperity contact pressure

In figure 16 is shown total pressure which consist of hydrodynamic pressure and asperity contact pressure.

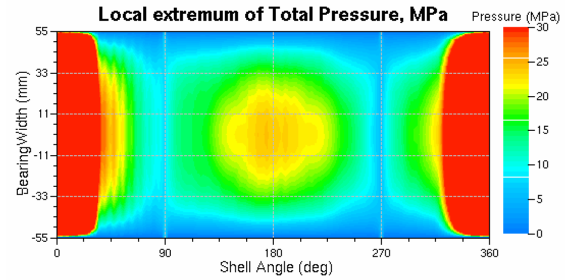

Figure 16. 2D results of total pressure

8. Conclusion

Connecting rod complex dynamical behavior and elastohydrodynamic bearings can be simulated with multy-body dynamic system simulation. From results we conclude that gas forces are dominant. If engine run on higher speeds, influence of inertia force will be higher. Continuing evolution of IC engines with demands for infinite fatigue life, fuel efficiency, exhaust emissions and reliability, in which dynamics, tribology and fatigue plays most important role. All these can be optimized in details with simulations. From dynamical results, inertia forces and elastohydrodynamic pressures can be exported for using in high cycle fatigue and fretting fatigue analysis of connecting rod. Bearings, piston assembly and valve train are most critical IC engine components from tribological point of view. Their frictional power loss is greater than 75 % of the total loss. From 2D results, conclusion for lowering oil viscosity can be evaluated because reduced oil viscosity directly decrease minimum oil film thickness and frictional power losses.

10. References

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ANALYSIS OF THE SHELF STORAGE OF FLEXIBLE ASSEMBLY CELL BY WITNESS SOFTWARE

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Abstract
Analysis of flexible assembly cell using witness software. Analysis is carried out at shelf storage system of flexible assembly cell. Aim of the simulation is to point out at possibility of exact programming of sample paths entering the shelf storage as well as at entire simulation time of assembly process.

Keywords:
assembly cell, analysis, production process

1. Introduction

Expression summarizing the time analysis of the production is actual production time. It is a time parameter representing the time of production process, which consists of time of general production operations and manipulation, verification and other secondary operations. Moreover, time of production as a parameter, expressed in calendar time units, includes also time of all interruptions and delays which takes place during product creation.

Fundamental factors affecting time structure of production process:

- duration of technological operations
- the size of benefits
- how to upload lots of parts,
- how to sort of plant,
- technical factors
- qualification of workers,
- length of routes,
- speed handling equipment,
- time control of operations break time,
- The level of production management [1].

2. The flexible assembly cell (FAC)

Time analysis was carried out at the flexible assembly line localized at IPSM. The flexible cell is composed of technological devices with software control using aids of automation of technological process which operates autonomously. Performed are various cycles with possibility of connecting to the system with higher level. Aids of automation are product storages with technological pallets, clamping devices, devices for tool exchange and vaste removal and diagnostics. The flexible production cell is frequently connected with industrial robot forming a robotic technological complex.

A material flow could be defined as an organized movement or circulation of material in production process. Material describes raw materials, tools, base and support material. The material flow is in its nature a realization of a supply chain.

3. Special analysis of flexible assembly cell

Prototype of the flexible assembly cell is localized at IPSM of the Faculty of Materials Science and Technology in Trnava.

Description of the flexible assembly cell

Device as a complex consists of a shelf storage and working area of the cell. Shelf storage serves for storage of half products, particular parts as well as of final products (Figure 1.). One of the roles of the storage is to recover the particular pallets with machined parts or pallets with components and place them on a rotating manipulation device which connects the storage with working area. The insertion of the pallets in and out of the working area of multifunctional industrial robot which performs production and assembly operations is realized with help of already mentioned rotating manipulation device. Part of the working area of industrial robot is a rotating clamping device which is able perform continuous rotating movement in a defined direction and velocity as for example clamping device of the lathe and simultaneously allows exact positioning of the machined part by rotating it around its vertical axis. Control of the entire device is realized with help of industrial PC. Device utilizes electricity and compressed air, that is pneumatic and electro pneumatic.

Important part of the project is also a Robot IRB – 120 aimed at palletization of components and depalletization of final products. Movement between Robot IRB – 120 and storage system (shelf storage) is realized with help of another robot, so called Robotino.

Prototype of the flexible assembly cell integrates 4 production stages which have to be passed by each product during the production process:

- Storage and transport of half product to a production device.
- Manipulation with particular components.
- Assembly of particular components into a final product.
- Manipulation and storage of final products for dispatch.

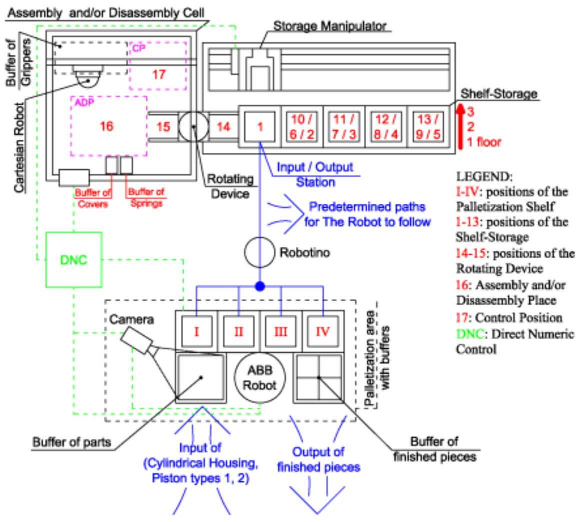

Figure 1. Layout-Model FAC

The storage system is served by 3-axis manipulator which guarantee material flow of 2 components – cylinder and piston.
Roles of this actuator are:

- pallets with components are inserted in the storage system (shelf storage),
- pallets with the particular component is retracted from the storage system and inserted in the rotation manipulation unit.
- pallet with assembled component is retracted from the rotating manipulation unit and is inserted in the place of unloading
- empty pallet is retracted from the rotating unit and inserted in the place of unload.

Cartesian robot – 3-axis robot with TTT kinematic structure. Kinematic chain is composed of translation kinematic dublets in three axises X, Y and Z. Working area of this robot is rectangular with dimensions of 1000x1000x350mm.
Its roles are:

- securing assembled parts, retraction and insertion from rotating device for clamping,
- realizes aasembly process with help of the two clamped heads,
- securing positioning of final product with respect to the rotating unite.

Robot IRB – 120 is despite of its relatively compact dimensions fully functional 6-axis industrial robot designed for flexible and compact productionin area of assembly, manipulationof devices for food industry, farmaceutic industry, industrial sollar energy for other various branches.
Its roles are:

- palletizing of particular componentsfrom storages to system pallets,
- depalletization of assembled components from system pallets to pallets for finallized (assembled) products.

The role of Robotino is to deliver system pallets with components from the area of Robot IRB 120 to storage area of the flexible assembling cell and subsequently deliver system pallets with final products and back.
Operation of flexible assembly cell
Operations of the flexible assembly cell represents assembly of the final product (part) composed out of 4 components – *wheel, piston, spring and cover* (Figure 2.). On the following image, various combinations of assembly is depicted.

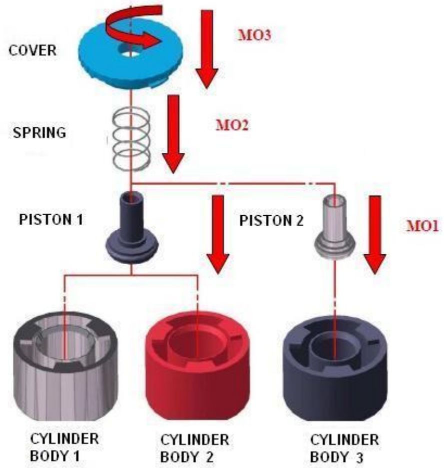

Figure 2. Assembling process of the component

Operation of the flexible assembling cell are composed from the following steps:

- shelf storage retrieves the pallet with cylinder body,
- rotating unit performs performs inspection of the cylinder body with help of the sensor attached to the console and 180° rotation toward working are,
- shelf storage retrieve piston and loads it to the rotating unit and simultaneously cartesian robot retrieve component from the rotating unit and inserts it orientation unit,
- rotating unit rotates 180°and simulataneously performs cylinder orientation,
- cartesian robot retrieve cylinder body from the orientation unit and inserts it to clamping system,
- shelf storage can add further new pallets in the shelf system and simultaneously cartesian robot performs exchange if the gripping head and gripper clamps the component,
- shelf storage can add further new pallets and simulataneously cartesian robot retrieve pisotn and inserts it into the cylindrical body,

- shelf storage can further add new pallets into shelf system, cartesian robot performs exchage of the gripping head and storage of springs pushes out a spring,
- cartesian robot takes the spring and slipt it over the piston,
- cartesian robot takes the cover and inserts it into the orientation unit,
- orientation unit performs orientation of the cover,
- cartesian robot takes the cover and assemble it with cylinder body,
- gripper releases the product,
- cartesian robot takes the product and inserts it into the unit for inspection of the functionality,
- rotating unit rotates for 180°and inspection station performs test of functionality,
- cartesian robot places the final product on the pallet,
- shelf storage retrieves the pallet with cylinder body and place it in to the rotating unit,
- rotating unit rotates 180°,
- pallet with finalized product is placed at input/output with help of the shelf storage.

4. Timing analysis of software with witness

Layout components – cylinder body and piston in the shelf storage are not fixed but are determined depending on the particular order. The simulation we chose a combination of 4 black, 4 red and 4 silver products. Calculations were monitored in three different variants of the layout of components (Figure 3., Figure 4., Figure 5.).

The removal from storage of components was used FIFO method of inventory management. **FIFO** - First In, First Out translates as first-in, first-out store. An item that is accepted as the oldest, so first in, the system must be written off and is removed first.

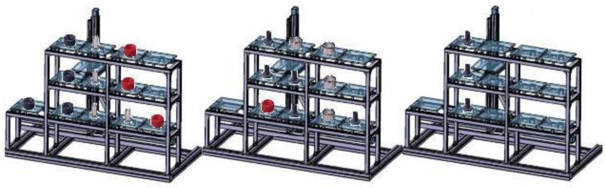

Figure 3. First variant distribution of components

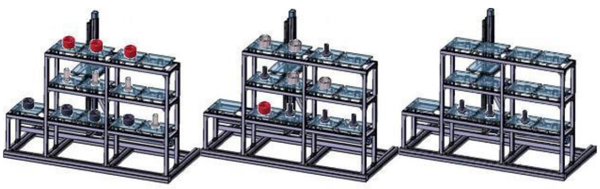

Figure 4. Second variant distribution of components

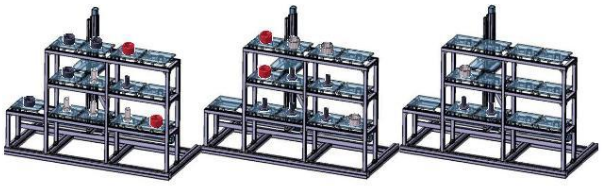

Figure 5. Third variant distribution of components

Simulation of the manufacturing process using a PC

There are three basic types of simulation: discrete, continuous and combined (hybrid). In most manufacturing processes using discrete simulation, because the points which had to change the state of production, show a continuous time course sequences in the real system

Computer simulation provides:

Express the processes for which we do not know the analytical solution,

- replace the real time and expensive experiments,
- carry out experiments with the proposed development tools,
- implement the changes and assess their implications,
- to examine the number of fault effects and alternatives to proposed solutions.

The created simulation is necessary to consider the drawbacks:

- model is not sufficiently precise to match the real system,
- creation of complex systems can be very time consuming and difficult to hardware, which will increase the cost of production.

It is therefore important that before exercise, the simulation was the need for a considered and practical contribution to the project proposal. [2]

Simulation in Witness

Witness the world's leading simulation software used in dealing with production, service and logistics processes. Allows you to simulate the working environment, simulate consequences of different decisions and understand no matter how complicated the process even before implementation of proposed solutions. Managers to help minimize the risks changes in society and the result are greater trust management companies for new projects. The system for creating interactive of visual simulation model. Dynamically displays movement and state of the elements (components) for the specified elements (reservoir, machine, conveyor, etc.). [1]

The assembly process in the assembly cell (Figure 1.) is the logical assembly procedures. It is possible to express relations so. relay, respectively. Contact, a full tree. Figure 2. The simulation is necessary to provide real time assembly and installation procedures to ensure logical [3].

The Figure 6 is a view of the assembly component. It should be noted that it is necessary to actually count and rejects that may occur during production. After the simulation is obtained by the performance of machines, handling utility.

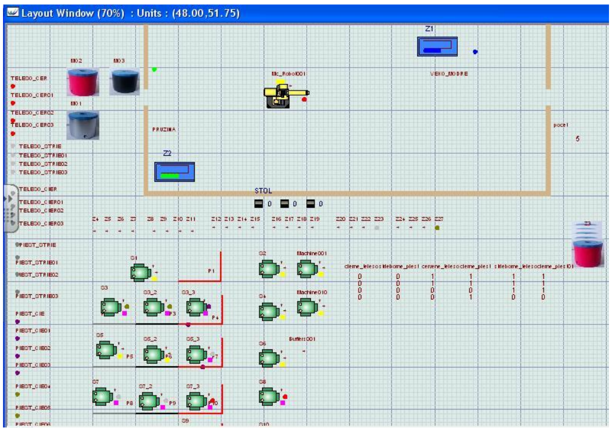

Figure 6. The simulation software the environment Witness

Simulation of the three variants of the distribution cylinder bodies and pistons in storage shelf and subsequent simulation of the assembly process, these results can be determined (Table 1.).

Table 1. Output value of simulation of the 3 storage of variants

Storage of variants	simulation time [-]	quantity of the component	time for one component [-]
1. variant	325	12	27,09
2. variant	442	12	36,84
3. variant	304	12	25,34

5. Conclusion

Evaluation of results with respect to the total assembly time. It is clear that, subject to the same length of road binder and rack mounting assembly the same group but different storage has an impact on the overall assembly time. Recalculation showed that the percentage difference is the assembly time to cca.30%. Therefore it is important to consider the store shelf components into the binder and the subsequent sequence assembly.

6. Acknowledgement

Authors appreciate financial support of VEGA 1/0206/09 Intelligent manufacturing assembly cell.

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SYNTHESIS AND CHARACTERIZATION OF PACK CEMENTED ALUMINIDE COATING ON STAINLESS STEEL

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Abstract

The aluminized coating on the X2CrNi19-11 austenitic stainless steel was produced by a pack cementation method at 1000 °C for 4 hours. For aluminizing process the following mixture of powders was used: aluminum in the form of fine powder applied to the substrate surface, $AlCl_3$ as an activator and corundum (α-Al_2O_3) as an inert filler in powder form to prevent sintering of powder mixtures at high temperatures. Aluminized sample was annealed in two 60-minutes cycles at 700 °C in oxidizing atmosphere. Microhardness HV 0.025 of bulk material and the aluminized coating was measured after aluminization and oxidation. Optical microscopy was used to investigate the microstructure and to measure the thickness of the coatings.

Keywords: austenitic stainless steel, high temperature aluminizing, oxidation.

1. Introduction

Aluminizing at elevated temperature is usually applied to improve resistance to corrosion and oxidation at high temperatures, as well as tribological properties of stainless steel and other metal materials. Aluminized coatings on steel consists of different Fe-Al intermetallic compounds (iron aluminide), such as Fe_3Al, FeAl, Fe_2Al_5, $FeAl_2$, Fe-Al. Most intermetallic compounds have a combination of attractive properties, such as low density, good wear resistance, simple deposition, oxidation resistance at high temperature. The high temperature resistance of most aluminides is based on the formation of protective Al_2O_3 coating after exposure to oxidizing atmosphere. This layer provides a good diffusion barrier at high temperatures, resulting in advanced durability of metal parts in the working conditions of an aggressive atmosphere. However, some aluminides have several poor properties at room temperature. For example, Fe_3Al strength decreases below 500 °C due to the structure transformation [1]. The properties of aluminides can be significantly improved by optimizing the coating composition and controlling the aluminizing processing parameters. Aluminizing metallic materials can be produced by various methods, such as aluminizing in a pack cementation powders mixture [1-4], immersion in the molten aluminum bath [5-7], by chemical vapor deposition [8-10], thermal spraying [11], etc.
The formation of aluminized coatings depends on the composition of the pack, temperature and duration of the process, as well as the used steel. In this research, high temperature aluminizing process in an inert atmosphere of the X2CrNi19-11 austenitic stainless steel, followed by oxidation of the obtained layers, was carried out.

2. Method

In this study, an aluminizing process was conducted on the X2CrNi19-11 (AISI 304) austenitic stainless steel. The chemical composition of this steel was determined by the glow discharge optical emission spectroscopy (GDS 850A, Leco) and results in wt. % were: C-0.03; P-0.038; S-0.025; N-0.07; Si-0.38; Mn-1.25; Cr-18.80; Ni-8.08 and Fe - balance.
Three test samples with dimensions of 20×20×20 mm were cut from a square bar. All samples were ground and polished and subsequently cleaned in water, then in acetone and finally in an ultrasonic bath with distilled water.
The composition of used pack powder mixture:
- 25 wt.% Al powder, as aluminum source,
- 2 wt.% anhydrous aluminum chloride ($AlCl_3$) as activator,
- 75 wt.% alumina (α-Al_2O_3) as the inert filler.

The pack powder mixture was homogenized in the ball mill (PM100, Retsch) at 300 rpm for 180 min, with addition of n-hexane (n-C6H14), in order to prevent powders oxidation due to the frictional heat.
Two samples were subjected to the heat treatment in a mixture of powders (sample 2 and sample 3). One of these two samples (sample 3) was subsequently subjected to the annealing in two cycles of 60 min at 700 °C in oxidizing atmosphere.
Description of the tested samples:
- sample 1: untreated X2CrNi19-11 (AISI 304) austenitic stainless steel

- sample 2: aluminized stainless steel at 1000 °C for 4 h.
- sample 3: aluminized stainless steel at 1000 °C for 4 h and then annealed in two cycles of 60 min at 700 °C in oxidizing atmosphere.

Following analysis were carried out on the cross section of all samples:

- microstructure analysis after polishing and after etching with aqua regia (a mixture of concentrated HCl and HNO_3 in the ratio 3:1) was performed by the optical microscopy, Olimpus GX51,
- the microindentation hardness of sample 2 and sample 3 was measured with the Vickers indenter (PMT-3) with a load of 0.245 (HV 0.025) for10.

3. Results and discussion

Figure 1 shows the microstructure of X2CrNi19-11 austenitic stainless steel observed by the optical microscopy. Irregularities were not observed in the microstructures.

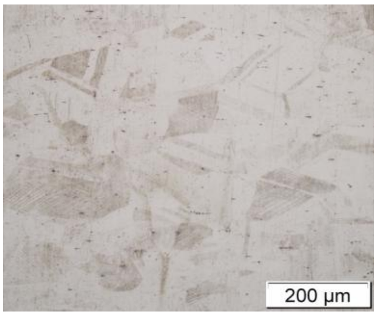

Figure 1. Microstructure of the untreated X2CrNi19-11 stainless steel (sample 1) after etching with aqua regia (a mixture of concentrated HCl and HNO_3 in the ratio 3:1).

Figure 2A shows the micrograph of the indentations in the intermetallic layers and base material of sample 2 (aluminized stainless steel), due to hardness test at 0.245 N (HV 0.025). The etched microstructure of the same sample is shown in Figure 2B. The etching was made using aqua regia (a mixture of concentrated HCl and HNO_3 in the ratio 3:1).

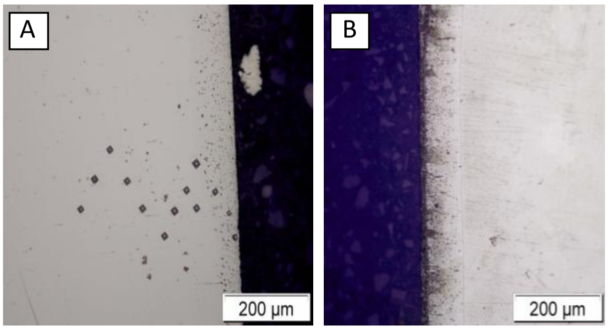

Figure 2. Cross section micrograph of: (A) aluminized X2CrNi19-11 stainless steel (sample 2) with the indentations of microhardness profiles under 0.245 N and (B) aluminized X2CrNi19-11 stainless steel (sample 2) after etching with aqua regia.

The hardness measurements were performed on the cross sections, from the surface to the middle of the samples, with a step of 25 µm. Indentations of the microhardness measurements after high temperature aluminizing and exposing to the oxidizing atmosphere are shown in Figure 3A. The microstructure of the same sample after etching with aqua regia is shown in Figure 3B.

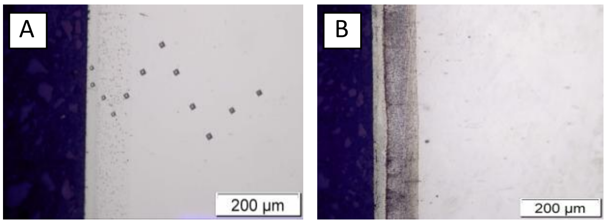

Figure 3. Cross section micrograph of: (A) X2CrNi19-11 stainless steel after aluminization and oxidation (sample 3) with indentations of microhardness profiles under 0.245 N and (B) X2CrNi19-11 stainless steel after aluminization and oxidation (sample 3) after etching with aqua regia.

The micrographs shown on Figs. 2 and 3 clearly indicate the difference between the aluminized layer thickness and corrosion resistance of the samples 2 and 3. Both samples were etched under the same conditions in aqua regia (a mixture of concentrated HCl and HNO_3 in the ratio 3:1). The surface layer of the sample 2 is severely etched and porous, while the same layer of the sample 3 is compact, unetched and without pores. This observation indicates that sample 3 shows better corrosion resistance in very aggressive media, i.e. aqua regia.

The thickness of the first layer after oxidation in two 60-minutes cycles at 700 °C equals approximately 40 μm. The thickness of the second layer is about 80 μm.

Mean value of the five microhardness measurements equals 460 HV 0.025. The microhardness of the second layer and base material remained equal as before the oxidation. The oxidation of the aluminized layer at 700 °C in two 60-minutes cycles improved not only the corrosion resistance, but also the microhardness of the X2CrNi19-11 austenitic stainless steel.

4. Conclusion

After conducted research and analyzed results, the following conclusions can be made:

- high temperature aluminization of the X2CrNi19-11 austenitic stainless steel in the pack powder mixture in the inert atmosphere at 1000 °C results in the formation of two surface layers,
- formed layers distinguish by their thickness and microhardness,

- subsequent oxidation of the aluminized layer in two 60-minutes cycles at 700 °C changes the layer's morphology,
- the first layer obtained on the aluminized and oxidized sample (sample 3) showed considerably higher corrosion resistance in very aggressive media, i.e. aqua regia, and higher microhardness, compared to the sample 2, which was just aluminized.

Obtained results indicate the possible improvement in corrosion and tribological resistance of the X2CrNi19-11 austenitic stainless steel at high temperatures, by the application of the high temperature aluminizing in the pack powder mixture.

5. Acknowledgement

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MEASURMENT AND ANALYSES OF BOGIE LATERAL ACCELERATION

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Abstract
During the bogie hunting, its lateral acceleration is constantly present. System for measurement and analyses of lateral accelerations will be presented in this paper. All measurements are done according to EN 14363 [1]. It will be described measurement principle, measurement equipment and result discussion.

Keywords:
Lateral acceleration, measurement, analyses, bogie, bogie hunting

1. Introduction

Lateral acceleration is measured according to EN 14363. For running safety of railway vehicle according to EN 14363, on-track test elements should be done in one option shown in figure 1. Vehicle is tested for initial acceptance so selected measuring method is simplified.

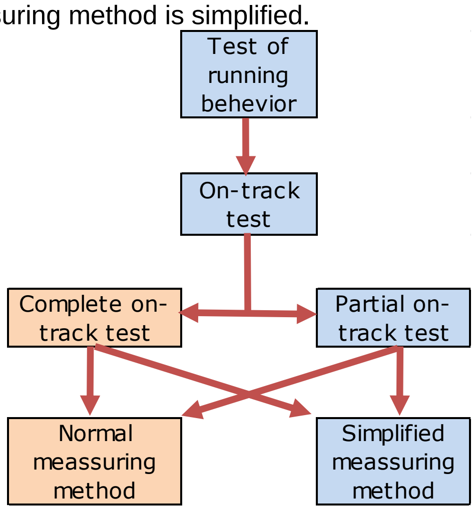

Figure 1. On-track test (chosen blue option)

On-track test is done for maximum speed of train. According to declaration of train producer, maximum speed is 140 km/h with 10 % tolerance. In this case means maximum testing speed should be 154 km/h.
The measurement is done with an amplifier of type MGC+ produced by Hottinger Baldwin Messtechnik GmbH (HBM). Amplifier is used with sampling rate of 480 Hz and anti aliasing filter at 80 Hz.
Accelerometers with sensors are sending collected data by cables to amplifier. Accelerometer type PJM LN is low cross axis sensitivity of 2 % tolerance and low noise 5 $\mu g/\sqrt{Hz}$ for the 2 g sensor. It is also high shock resistant. The output signals of the sensors are amplified, filtered and digitalized by the amplifier MGC+. All processed data are stored in PC and visualized by AMS Beam software.

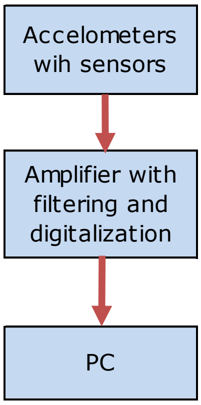

Figure 2. Scheme of the measuring chain

Figure 3. Measurement spot on the bogie

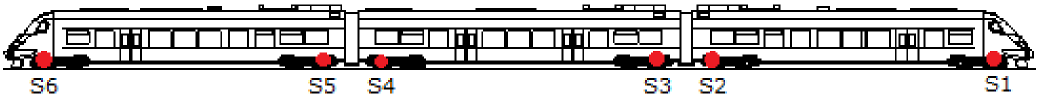

Figure 4. Measurement spots on the train (S1-S6; measurement spots)

For measurement are used 6 accelerometers with sensors. Each sensor is spotted on bogie frame above outer axle of each car (figure 2, figure 3 and figure 4).

2. Mathematical model of maximum acceleration

Practice for proving stability in engineering applications is to analyse lateral accelerations on the bogie frame. Lateral acceleration on the bogie frame is used to check the bogie stability, also without the calculation of rms-value [2].
This model is only used in simplified measuring method when measurement of lateral axle box forces is not carried out. According to EN 14363 [1] **Pogreška! Izvor reference nije pronađen.Pogreška! Izvor reference nije pronađen.**and also UIC 518 [3] stands:

$$\ddot{y}^{+}_{\text{max, lim}} = 12 - \frac{m^{+}}{5} \qquad (1)$$

where is:

$\ddot{y}^{+}_{\text{max, lim}}$ - maximal limited bogie lateral acceleration in m/s^2

m^{+} - mass of the bogie in tons.

Maximum speed of vehicle according to EN 14363 is calculated as:

$$v_{\text{max, lim}} = 1{,}1 \cdot v_{\text{max}} \qquad (2)$$

where is:

$v_{\text{max, lim}}$ - maximal limited train velocity in km/h

v_{max} - maximum declared train velocity in km/h.

3. Technical properties of train

For commercial usage nominal speed of train should be 140 km/h. According to **Pogreška! Izvor reference nije pronađen.**, test speed is:

$$v_{\text{max, lim}} = 154 \text{ km/h} \qquad (3)$$

Other technical data is shown in table 1.

4. Maximum accelerations for test train

Using equation (**Pogreška! Izvor reference nije pronađen.** for each bogie is calculated:

$$\ddot{y}^{+}_{\text{max, lim1}} = 10{,}24 \text{ m/s}^2 \qquad (4)$$

$$\ddot{y}^{+}_{\text{max, lim2}} = 10{,}64 \text{ m/s}^2 \qquad (5)$$

$$\ddot{y}^{+}_{\text{max, lim3}} = 10{,}75 \text{ m/s}^2 \qquad (6)$$

$$\ddot{y}^{+}_{\text{max, lim4}} = 10{,}24 \text{ m/s}^2 \qquad (7)$$

$$\ddot{y}^{+}_{\text{max, lim5}} = 10{,}64 \text{ m/s}^2 \qquad (8)$$

$$\ddot{y}^{+}_{\text{max, lim6}} = 10{,}24 \text{ m/s}^2 \, . \qquad (9)$$

Table 1. Measurement spot on the bogie

Weight	158 500 kg
Wheel diameter	850 mm
Maximum speed	140 km/h
S1: Bogie 1 weight	8790 kg
S2: Bogie 2 weight	6791 kg
S3: Bogie 3 weight	6275 kg
S4: Bogie 4 weight	8790 kg
S5: Bogie 5 weight	6791 kg
S6: Bogie 6 weight	8790 kg
Gauge	1435 mm
Distance between bogie centres	17 000 mm
Distance between axles in bogie	2300 mm
Total length	70 450 mm

5. On-Track testing

Measurement is done at speed 154 km/h (from figure 5 to figure 30). After the essential stability and curving requirements are met, it is considerations of ride quality which dominate the detailed design of railway vehicle suspension systems. The layout of curves is defined by the maximum cant of the track, and vehicle speed, so that the lateral acceleration applied to passengers is within acceptable limits [5].

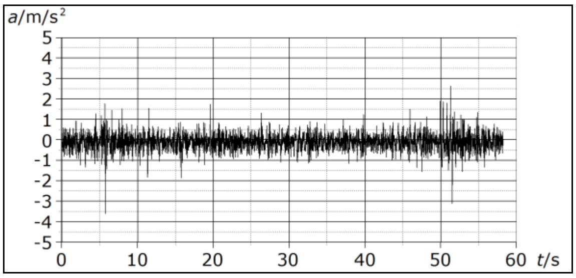

Figure 5. Data from accelerometer at spot1

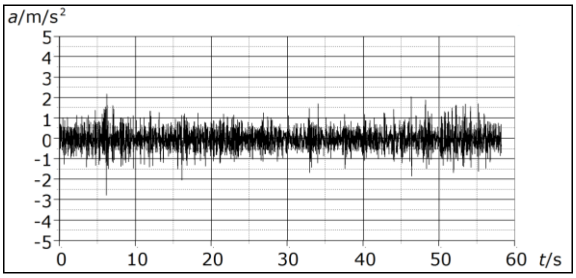

Figure 6. Data from accelerometer at spot2

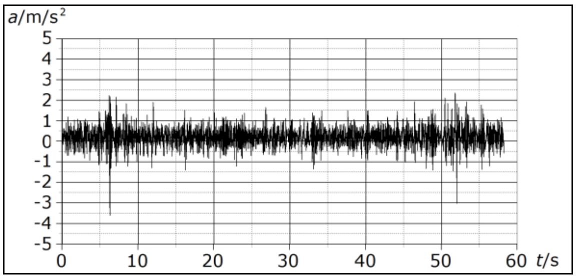

Figure 7. Data from accelerometer at spot3

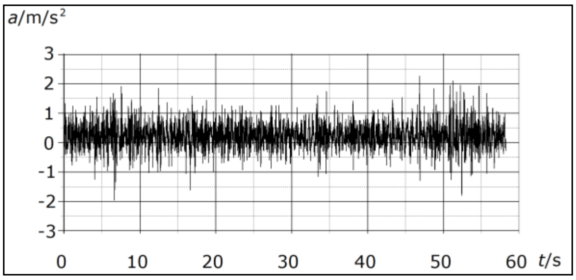

Figure 8. Data from accelerometer at spot4

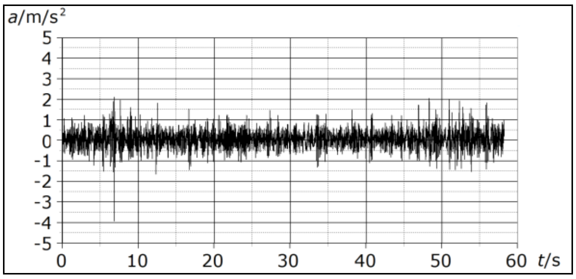

Figure 9. Data from accelerometer at spot5

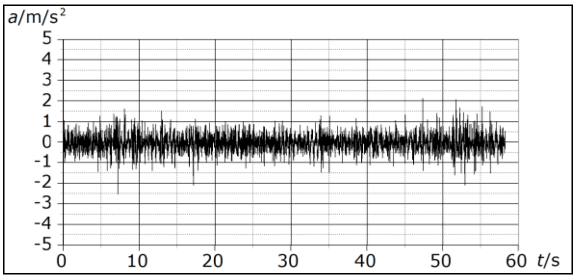

Figure 30. Data from accelerometer at spot6

6. Discussion

Figures from 5 to 3 show stability assessment using simulation results from a run on straight track. All the signals mentioned can be used to prove the stability by simulation.

From diagrams it can be seen that all values are not exceeding maximum limits. All values didn't exceed $\left|\ddot{y}^{+}\right| = 5\ \mathrm{m/s^2}$ and there is no risk of derailment. All amplitude peaks are caused by railway track irregularities.

After this first run of new vehicle at maximum speed, vehicle is safe for other testing on curve lines.

7. **Conclusion**

This initial on-track test is done as additional insurance against derailment while vehicle was tested with other measurement methods as braking, rolling, etc. All collected data from sensors are under limit value and acceptable. Stability is approved and vehicle can be proceed to next testing methods.

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APPLICATION OF POLYMERS IN PRODUCTION OF TRANSPORT VEHICLES

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Abstract
Today, regarding volume more polymers than steel are used for the manufacture of the transport means. The reasons are various; technical ones include large freedom of design, aesthetic characteristics and dynamics, and the industrial ones include the possibility of selecting the manufacturing procedure which allows mass production, small batches, special models, etc. The ecological reasons require reduction of the fuel consumption and gas emissions, and they mean lighter vehicles and improved streamlining. At the end of the vehicle life-cycle the plastic components can be recycled or energy recovered by combustion. The vehicle industry requirements are a great challenge for the designers, because of balancing the affordable price, excellent service characteristics, reliability, comfort, safety, etc. The paper includes the design and manufacture of electromotor-powered vehicle which can be used on various difficult terrains, on snow, water, sand, mud and on big slopes where no modifications need to be done when changing the mentioned surfaces.

Keywords:
Design, polymers, production, transport vehicle

1. Introduction

The polymeric materials have a significant share and the importance of applications in technical purposes; they are also one of the first materials known to humans. These were then natural organic polymers such as wood, leather, and other fibres of plant and animal origin.

Polymers are natural and synthetic, organic and inorganic substances and materials with macromolecules as their basic component. They are classified into three main groups according to their behaviour at higher temperatures, and these are thermoplastics, thermosets and elastomers. [1]

According to the set requirements the vehicle conceptual design (Figure 1) consists of a wooden construction, two rollers made of polyethylene (PE-HD) to which rubber is stuck in the form of a coil, five bearings that insure the suspension for vehicle movement on large gradients, and other elements necessary to control the vehicle. The vehicle is propelled by two direct-current electromotors. Every electromotor is connected by a belt to a roller. The electromotors are controlled independently and this allows the movement of vehicle in all directions.

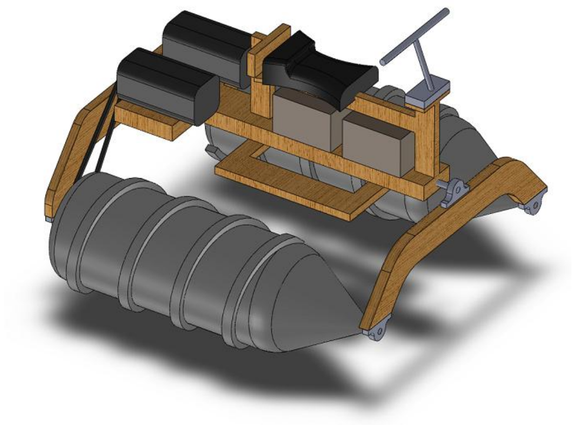

Figure 1. Vehicle concept

In vehicle manufacture the crucial part is the tube of 500 mm in diameter. The set mechanical requirements would find it suitable to have a tube made by winding of glass fibres and application of polyester resin as matrix or by the application of standard thermoplastic tubes produced by extrusion. Annually in the world more polyethylene is produced than any other type of polymer. It is used for the production of films and foils, and injection moulded, blown and extruded products. It owes its wide application to its small mass, excellent chemical properties, ease of processing and relatively low price. [2] The PE-HD melting temperature is within the range from 132 ºC to 135 ºC, the softening temperatures amount to 127 °C. It features excellent properties of resistance to water and water vapour, but not to gases. When exposed to UV radiation, polyethylene is subjected to the processes of chemical or thermal degradation. These processes occur at reduced molecule mass, generation of low-molecule products and cross-linked structures at significant reduction of mechanical and electrical properties. The degradation increases during the process at increased temperatures or longer exposure to the elements. [3]

Wood is a natural organic material and it is one of the first polymeric materials which was used for technical purposes. As design material wood has many advantages over other materials; it has low specific weight, low price, it is suitable for a wide variety of, very inexpensive and rapid manufacturing, it is easy to maintain and has high resistance to fatigue [4]. However, wood has also big disadvantages. On the first place are the non-homogeneity and anisotropic characteristic of the material. This leads to the fact that the mechanical properties of wood depend on the direction of the loading force in relation to the direction of fibres. Wood is subject to the influence of insects, microorganisms and atmospheric changes. A very significant factor is also the humidity of wood. The content of humidity affects to a significant extent the mechanical properties of wood. The increase of humidity by 1% causes decrease in strength by 3%, pressure by 5%, the bending 4%, shear 3%, hardness by 3%, and module of elasticity by 2%. The highest failure strength of wood is obtained at the humidity of about 7,5%. [4]

2. Vehicle design

The volume of rollers has to be sufficiently big for the vehicle to be able to move over water, which means that the total weight of the vehicle including the driver has to be lower than the roller buoyancy. For the vehicle to be able to move over irregularities it is necessary to reduce the diameter on the front part of the tube. The spirals on the tubes allow the movement of vehicle during the rotation of the rollers, and they are adhesion attached to each roller in the opposite direction. When the rollers rotate at the same angular velocity in opposite directions the vehicle moves forward or backward depending on the direction of rotation, and when the rollers rotate in the same direction, depending on the direction of rotation the vehicle moves to the left or to the right. The vehicle turning is realised when the rollers rotate at different angular velocity. When the vehicle moves forward or backward at each roller revolution the vehicle makes a shift that is equal to the gap between spirals, and when moving sideways the vehicle speed is equal to the product of angular velocity and roller radius.

The volume of both rollers has been selected (V = 500 l) and the roller diameter d = 500 mm.

In order to realize the volume of one roller of 250 l the length of tube for the roller is 1500 mm. The tube in the length of 1500 mm and diameter of 500 mm has a volume of 295 l, but according to the conceptual design the tube diameter needs to be reduced at the beginning thus reducing also the volume. The calculation of the wall thickness has been done in the software program *SolidWorks* in such a manner that according to the total vehicle mass including the driver, the tube was loaded in the ways in which it will be loaded during use. Figure 2 shows one of the ways of loading, i.e. the respective elastic deformations.

In the area of highest deformation (marked red in the Figure) the tube is loaded by a force in the amount of F = 2200 N and it deformed by 5,526 mm. After detailed analysis and optimization of the tube, the tube of standard dimension relation 41 has been selected which means that the wall thickness amounts to 12,3 mm.

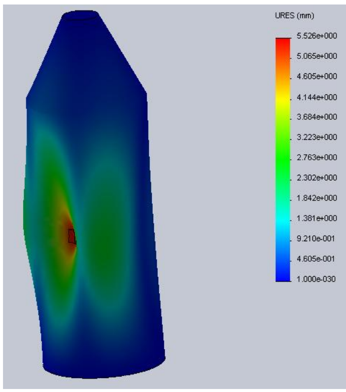

Figure 2. Analysis of tube deformation

3. Preparation of PE-HD tubes

Reinforcements need to be installed within the tube. The reinforcements are made of two plywood boards 480 mm in diameter with the central bore for the axle which is 34 mm in diameter. On the plywood perimeter four 50 mm-wide grooves are made into which oak boards are inserted (Figure 3).

Figure 3. Installation of reinforcement and centring the front part

The connection between the boards and plywood is insured by adhesion, and between the wooden construction and the tube the joint is secured by screws. A favourable transfer of the torque from the shaft to the tube flange needs to be insured, so that four steel sheets are set on the tube flange.

Since the axle was not located in the centre of the tube, after the sheets have been placed the bearings with housings are placed. The housings are attached so that the tube can rotate freely and then a rope is placed above the tube in order to make precise adjustment of the gap between the tube and the axle. The tube is gently rotated and sheet spacings are installed and the axle and tube centricity is achieved (Figure 3). After the sheets have been set REL welding is done on the set sheets with the axle. During welding the tube needs to be protected in order to avoid its damaging. The tube is protected with moist cloths which remove heat and insure that there is no contact between the tube and the slag. A metal bar is additionally welded onto the sheets and it is

coated by primer. On the tube front the torque needs not be transferred and only bars are installed in order to achieve the centricity and as additional reinforcement.
For the vehicle movement forward – backward it is necessary to paste extruded rubber coils on the tube. The adhesion bonding of PE-HD with rubber is not a standard procedure, so that before bonding the tube and the profile a test of the method of preparing the surface has been carried out. After adhesive curing, the joints were loaded and it was determined that the strongest joint was obtained by a combination of rubber profile treated by a metal brush and an open-flame heated tube and before cooling additionally treated by a metal brush.
A layer of adhesive is applied to the machined surfaces by a brush, and a rubber profile is rolled onto it (Figure 4). The additional reinforcement between the tube and the rubber profile has been insured by screws.

Figure 4. Adhesion of rubber profile

4. Manufacture of the front suspension and bearing construction

The front suspension has been made by the application of the natural polymeric material, wood. The applied wood was oak. The front suspension was bonded by adhesion and screws on which the bores were additionally treated by sinking. On the suspension itself the bearings with housings are set for connection with the supporting oak structure. When creating the supporting structure sufficient strength needs to be achieved with minimal mass of the structure. The residual stresses that are concentrated along the annual rings of the boards reduce their loading capacity, and this is the reason why the boards are sawn to smaller dimensions, i.e. during sawing of the boards the residual stresses decrease. On the supporting structure from the bottom a metal axle is placed (bright drawn steel) 30 mm in diameter which penetrates the bearing with the housing that is located on the front suspension. The axle is screwed to the supporting structure, and stiffened by the board.

5. Vehicle control

The vehicle drive is achieved by two electromotors of P = 1 kW power and U = 24 V voltage. The first electromotor has a mass of m = 30 kg and nominal number of revolutions of n = 1300 rev/min, whereas the other is of mass m = 20 kg and nominal number of revolutions of n = 1400 rev/min. In order to be able to move the vehicle in the desired direction it is necessary to insure independent control of electromotors, which has been done by switches and circuit breakers. The rotational movement of the electromotor rotor must be transferred to the roller and sufficient torque to start the vehicle should be insured by belt transmission. The required transmission ratio has been calculated by the torque (T).

$$T = \frac{P}{\omega} = 7{,}3Nm \qquad (1)$$

By reducing the number of revolutions by belt transmission the torque on the shaft is proportionally increased with the transmission ratio of the belt transmission.The electromotor torque is transmitted to the rollers by pulleys attached to the roller shaft and the electromotor rotors. Since electromotors have different nominal rotational velocity it is necessary to provide different transmission ratios for each electromotor. A 90 mm diameter pulley is set on the electromotor with lower nominal rotational velocity and a pulley of 60 mm in diameter is set on the electromotor with higher nominal rotational velocity. Bigger pulley is made of aluminium casting in sand and the finishing by separation of particles, whereas the smaller pulley is made of steel and machined by particle separation on a lathe. The pulleys that are set on the roller shafts are 275 mm in diameter and they need to be machined and outer sleeves are produced for them by lathing, of external diameter of 35 mm and internal diameter of 30 mm. The pulley of the roller and electromotor is connected by 17mm wide V-belt. In electromotor with higher nominal rotational velocity the transmission ratio of 4,5 is achieved by belt transmission, and in electromotor of lower nominal rotational velocity the transmission ratio is 3.

6. Vehicle assembling

After producing all the necessary parts and assemblies it is necessary to assemble the vehicle. Vehicle assembling starts by setting the plastic tubes at the necessary spacing. The front suspension is placed on the tubes and it is attached to the bearing housings by means of screws. After the front suspension the supporting structure has to be set. Before setting the supporting structure, stops are set on the rear axles, and these stops are used to adjust the position of the supporting structure in relation to the tubes and the V-belts. The bearings of the supporting structure are set on the rear axles of the tubes and the supporting structure is connected with the front suspension. Electromotors are set on the supporting structure, fixed by screw bars. Batteries and switches are placed into the supporting structure box. Four batteries are set, two each serially connected to every electromotor. The batteries are connected by wires over the fuses with switches and with electromotors. The final switches are connected by wires over the lock with the switches. A wooden cover and a seat are placed on the box of the supporting structure.

7. Vehicle application

The produced transport mean can be applied for moving on snow, water, sand and mud. Depending on the direction of the roller rotation the transport mean can be used for the movement forwards, backwards, and sideways to the left and to the right. Depending on the roller rotational velocity the transport mean can move to the left or to the right. The transport mean also has an independent suspension, and it may move along large gradients. An independent suspension enables that when a roller passes over a barrier only this roller inclines whereas the other roller keeps contact with the entire surface. This results in smaller vehicle inclinations as opposed to the situation if the suspension were rigid (Figure 5).
However, when moving on water the suspension needs to be stiffened. The suspension is stiffened by means of two screws and two sheets (Figure 6).
The vehicle can also move on hard surfaces but only sideways.

Figure 5. Independent suspension

Figure 6. Suspension stiffening

8. Conclusion

Due to their low density, i.e. low mass, good chemical stability, good tribological properties (wear resistance and low friction factor), good vibration damping and good insulation properties, the polymeric materials have become indispensible in the manufacture of products in automotive and aircraft industry, shipping industry, civil engineering, medicine, electrical engineering, in sport, etc. During the design and manufacturing of vehicles it has been found that the polymeric materials feature many advantages in relation to other types of materials, and these are: low density, no corrosion, cheaper, they can be rapidly primary shaped and deformed, good vibration damping and they are good thermal and electrical insulators. Using polymeric materials low-mass structures can be made, of good mechanical properties. By combining various polymeric materials the desired sliding properties can be achieved, so during vehicle movement between the rubber coil and the surface high friction factor has been achieved, and between the polyethylene tube and surface a relatively low friction factor has been achieved.
The testing of the developed prototype of the vehicle made of polymeric materials has led to the conclusion that the vehicle meets the set requirements. The vehicle can move on snow, water, sand, mud, various difficult terrains and can manage large slopes. The produced vehicle has the ability to move along the mentioned surfaces in all directions, and due to the favourable properties of the rubber profile, the vehicle allows moving along hard surfaces such as asphalt and concrete, but only sideways.

9. Acknowledgement

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DEVELOPMENT OF INNOVATIVE SOLE DESIGNED FOR RECREATIONAL ATHLETES

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Abstract
There is constantly a worldwide increasing impetus of development in all the fields of industry. Such a situation exists also in the manufacture of products made of polymeric materials. Thus, a new product has been developed which was stimulated by recreational running, i.e. by the sensation of knee ache which was the result of using improper running equipment. Because athletic shoes intended for other sports were used for recreational running, the ankles and knees had to endure severe loads that were created during running. Every athletic shoe for a specific sport has a different sole structure. The new structure should allow the soles to “absorb” loads that occur during running, so that they would not in turn be transferred to the athlete. The only solution currently available on the market is to buy new athletic shoes intended for running only. The new product (sole) will be attached to the athletic shoe not intended for running, and precisely in order to achieve the respective purpose.

Keywords:
Design, polyurethane, product development, rubber, sole

1. Biomechanics of movement

When walking or running, the movements of feet and legs forward and back may seem simple, but it is a complex series of movements. In these series harmonious working includes all the muscles, tendons, bones, joints, connections and nerves. This complexity is reflected in the fact that not even two consecutive steps are exactly the same. The angle of the foot, footwear, and surface gradient along which a person is running (or a small pebble under the foot) compel the person to step each time differently onto the ground. All such information has to be accepted, processed by the brain and then sent back to the limbs. This process is so complex that it is impossible to develop a completely accurate mathematical or computer model of a person’s foot. [1]
When a person running steps on the heel, there is only 0,2 to 0,3 seconds of contact with the ground. This process can be divided into three main phases (figure 1). [2, 3]
In the **first phase** the recreational runner leans on the heel with a mass double their own weight. In this contact with the ground the impact has to be first mitigated. For this reason the heel of the athletic shoe has been divided into several segments which meet their specific function. After the heel strikes the ground, the foot bends inwards, with the aim of optimally landing on the ground. At this moment the ground resistance power weakens the impact power. [2]

Figure 1. Foot movement cycle [4]

In the **second phase**, the heel-supporting phase, the middle of the foot and its front part have contact with the ground. In this phase several elements of the athletic shoe are active. Specifically, the two concave elements of a stronger material centre the foot into the neutral position, and for additional stabilisation, on the inside of the foot, the stabilizers of convex form are also used. [2]
In the **third phase**, the acceleration phase, the heel is no more in contact with the ground. The foot is stiffened in order to more efficiently jump off the ground, and for this purpose thermoplastic platform is used, which serves to transfer power. In this phase the pressure is distributed from the back forwards, thus making it possible to use the work of muscles as the driving force. [2]
When running, the majority of recreational runners land on the heel, not using their natural system for impact mitigation and the system for stabilization. Figure 2 shows the abrupt transition effect at the moment when the runner’s heel comes into contact with the surface which causes numerous injuries of recreational runners. [4]

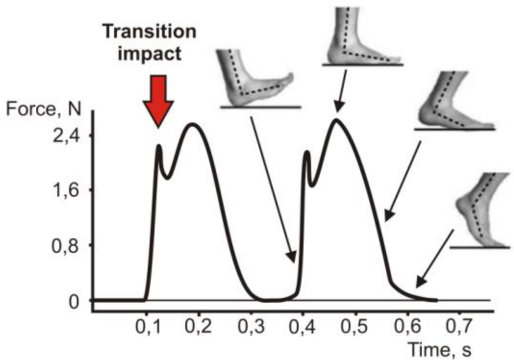

Figure 2. Flowchart of the foot force on the surface with the rear-part-of-the-foot running technique [5]

The professional runners run using the front-part-of-the-foot running technique. Figure 3 shows how, at the time when the runner has touched the surface, the sudden transition impact failed to take place. The absence of a sudden transition occurs because the foot has managed to absorb the impact of the foot upon the surface. For this reason this running technique is much more acceptable because it mitigates the impact and does not transfer the load onto the person. [4]

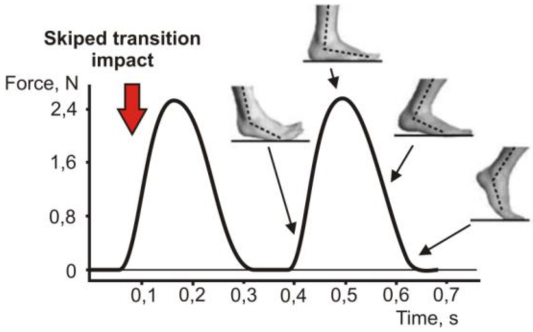

Figure 3. Flowchart of the foot force on the surface with the front-part-of-the-foot running technique [5]

A foot consists of a total of 26 bones, 19 muscles and 107 tendons. These all work together and mitigate the impact and stabilize the foot on a smooth or rough terrain, in a curve or on a hill. [2]

2. Anatomy of running shoes

Every pair of running shoes is made of three basic components (figure 4).

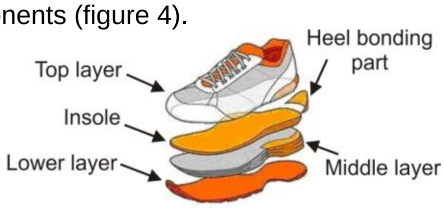

Figure 4. Basic elements of running shoes [6]

The upper layer is made of soft, airy and lightweight material for comfort. There are also various ways of sawing which contribute to the comfort of the athletic shoes, by adjusting to different foot widths. Its functions are to keep the foot in the planned position during running, part for the heel, heel fixer, heel wedge, ankle wrap, flap, tying system, etc. [6]

The main role of the **middle layer** is to insure maximum absorption and stability. Thus, this layer maintains the proper foot contact with the surface. The middle layer is at the same time resistant to impacts and instability (otherwise the absorption and the movement control are in negative relation). Here, the absorption depends a lot on the compressibility of the material of the central sole. The more this part is compressed, the more movement will the athletic shoe allow. On the other hand, the less the middle layer is compressed, the better the movement control [1]. Most running shoes use for the front layer foamed materials, e.g. polyurethane (PUR), ethylene/vinyl-acetate (EVAC) or a combination of both. [1, 7]

The bottom layer is in contact with the ground, and as such has the role of good adhesion to the ground, and should be resistant to wear and should direct the runner forwards. It has been designed in different forms, in order to provide maximum ease of movement on various types of surfaces.

3. Development of the sole

The sole design has been made for size 46, which according to ISO 9407:1991 standard of measures covers the foot length of 308 mm to 315 mm [8]. The design has been done according to the dimensions of the foot curve presented in Figure 5.

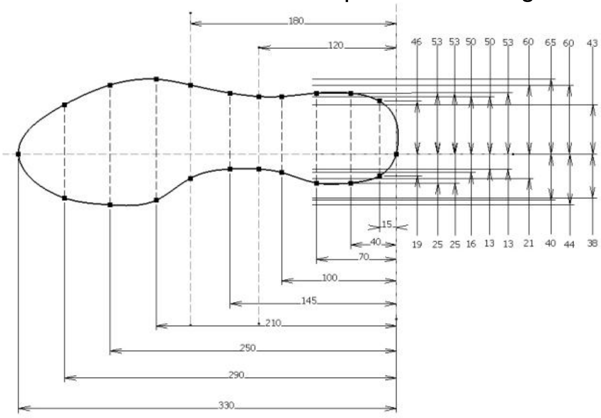

Figure 5. Foot curve

In the **first version** (figure 6) on the part which supports the heel a “snakelike” profile has been designed which after the part for the heel takes the form of a supporting bridge. On this part, which is located between the heel and the front part of the foot, in proper running there is no pressure from above, since the foot leans on the heel and on the front part of the foot, so that no reinforced support is necessary in that part. Such a solution of the central part reduces the overall mass. The zone for the front part of the foot is designed as a full profile with hollowes that have been adjusted to the sole height.

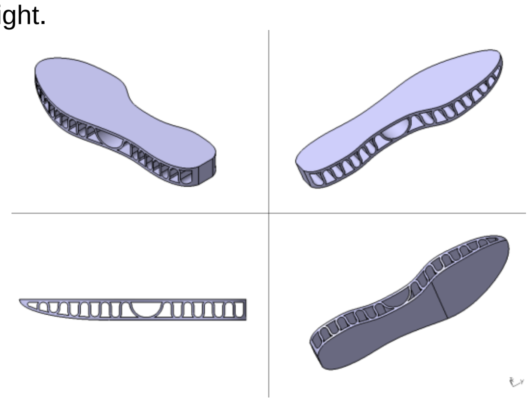

Figure 6. First sole design

In the **second version (figure 7)** of the sole different geometric shapes have been applied. On the part intended for the heel support two elliptical rings have been used. On the part between the heel and the front part of the foot a bridge has been used created from the half of ellipse, with the function of connecting the mentioned parts. After the central part, the front part of the foot is visible which has resulted from making of circles. Each circle has its own radius in proportion with the curved surface of the bottom part of the sole, in order to achieve the same wall thickness of the sole at all distances.

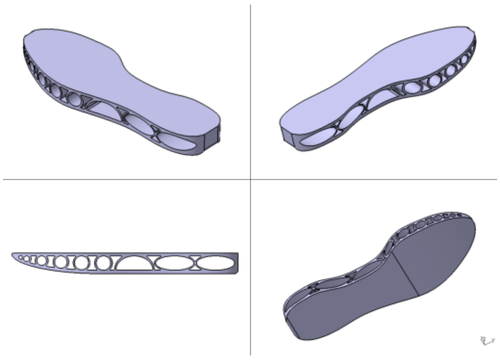

Figure 7. Second sole design

For the first two sole versions the manufacture of the mould is complicated and expensive because of realizing all the irregular cavities within the sole. One of the ways of making the mould would be to use the milling procedure to make a cavity in the mould, of given depth to the outer profile of the sole, and to centre inside it the segments which would correspond to every position by their dimensions. Certainly, the production of such segments (the majority of which are of different irregular dimensions), and their centring within the mould would significantly increase the price of manufacturing the mould itself. This would also increase the price of production, which would in turn be reflected on the price of the product itself.
In the **third version** of the sole (figure 8) the closed cavities within the sole have been removed, thus enabling simpler and cheaper mould design, free of demanding segments that should be centred within it.

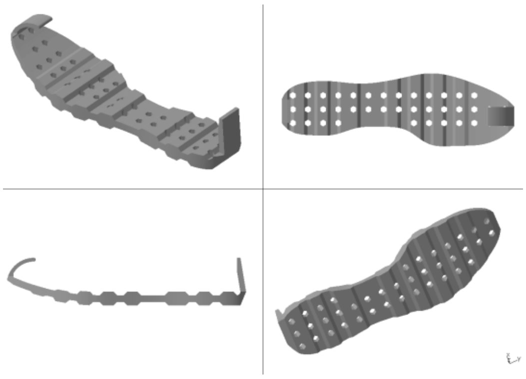

Figure 8. Third sole design

The structure has been designed with multiply connected octagons, of customized side lengths. Because of mass reduction, forty-six holes of regular hexagonal shape have been cut on the sole. With this procedure the sole volume has been reduced from $4{,}292 \cdot 10^4\,cm^3$ to $3{,}921 \cdot 10^4\,cm^3$ thus achieving a saving of 8,6 % of the volume without the tying system.
The attaching of soles has been solved by a system that allows the athletic shoe to be just pulled over the sole. Such tying system simplifies the tying operation, and shortens the spent time. The tying system should be made of rubber which allows sufficient stretching and contraction, without the material entering into the zone of permanent deformation. However, by using rubber the pulling of the sole onto the athletic shoes would be difficult, because of the high friction factor, so that it is necessary to stick on the inside a thin film of material to facilitate sliding of the athletic shoes into the soles. Such a tying system would significantly optimize its purpose of positioning the athletic shoe on the sole itself (figure 9).

Figure 9. Final sole design

The sole can be divided into several segments (Figure 10) each of which has its own function:

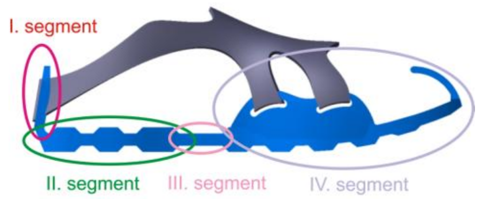

Figure 10. Sole segments

- segment I (heel support) – bevelled by 9,5° towards the inner part, in order to achieve best possible contact with the rear part of the athletic shoe. It serves also as the holder of the tying system which passes through it. At the bottom of the heel support a large radius has been designed in order to reduce the takeoff force to a minimum, thus avoiding the possibility of tearing of the heel support from the sole platform;
- segment II (heel part) – it is in contact with the heel part of the athletic shoe. Its function is the most important when mitigating the loads that result during running, i.e. it mitigates the transition influence which, if not absorbed, affects directly the runner. Therefore, the heel part has been

designed in the form of three “small pads”, whose role is to absorb the loads during running;
- segment III (central part) – in the central part the series of pads has not been continued, since on this part the foot has no support during running, thus making the sole lighter without unnecessary thickenings and additional flexibility has been achieved on this part;
- segment IV (front part) – on the front part there are specially designed tying system holders and a small tab at the top. It has the function of fixing the front part of the sole to the athletic shoe, thus preventing undesired sliding of the front part of the sole during running under the influence of inertia. In designing the front part certain changes have been made in the size of the octagons which follow in a series towards the top of the sole because it has been noticed by studying the second and the third phases of foot movement and the flowchart of the foot force on the surface, that in this part the force is gradiently reduced as the foot is coming closer to the end of the cycle.

8. Conclusion

The sole is intended for recreational athletes who opt for occasional recreation by running, and do not have the proper footwear required. The reason why the product is intended only for recreational runners is primarily that professional runners use a different running technique, i.e. they use the front part of the foot. This technique absorbs the large load in the first phase of the foot movement cycle, and avoids the transition impact of the force on the runner, because of which they do not suffer from the same difficulties as the recreational runners. Because of these differences in the running techniques, also the design of the very athletic shoes intended for recreational and professional runners is different. Naturally, the athletic shoes that have been developed for professional runners, regarding material and their design are at a very high technological development level, which places them on a higher price rank.

The goal of this paper was to develop and design a product that will represent an optimal solution as replacement for buying the athletic shoes for recreational running.

The very conversion of the athletic shoes consists in pulling the sole onto the existing athletic shoe. The tying system has been made of flexible material which enables inserting the athletic shoe into the sole and then insures sufficiently strong bond, in order to prevent athletic shoes from sliding during running. After having positioned the sole, on the soles of the existing athletic shoes the necessary deformation zone is achieved, which allows absorbing of the resulting loads that occur during running. This addition in the form of additional sole, namely, enables a larger deformation zone on the parts that are exposed to biggest loads. This refers first of all to the part below the heel, which is the first to be affected during running and which transfers the loads to the ankles, knees, hips and to other body parts.

The proposal of material selection for the bottom part of the sole is polyurethane of hardness H = 40 – 45 Shore A which enables the absorption of the resulting forces during running and of density $\rho = 400 - 450\ \mathrm{kg/m^3}$ made as integral foamed mould by RIM (reaction injection moulding) procedure. The best way of making the tying system is by direct or indirect moulding of styrene/butadiene or natural rubber which has good resistance to stretching and atmospheric factors, and is attached to the sole by adhesion or rivets.

9. Acknowledgement

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THEORETICAL DETERMINATION OF ELASTICITY CONSTANTS FOR STEAM BOILER MEMBRANE WALL AS THE STRUCTURALLY ORTHOTROPIC PLATE

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Abstract
Membrane wall of the steam boiler is structurally orthotropic plate. At structural analysis of boiler, finite element of the orthotropic plate is applied, whereat it is needed to have equivalent stiffness of the membrane wall. In this paper, the theoretical procedure of calculating of elasticity constants for membrane and bending stiffness of membrane wall is presented. Theorem of minimum total potential energy is applied. Mathematical expressions are given and by means of them it is possible to calculate equivalent constants of elasticity very simple.

Keywords:
elasticity constants, steam boiler, membrane wall, structurally orthotropic plate

1. Introduction

The membrane wall of the steam boiler has the function of heat exchanger. Along with thermal stresses and stresses caused by the pressure of the working fluid, the membrane wall is a bearing construction loaded with its own mass, mass of the working fluid, mass of fouling, mass of refractory and insulation, mass of equipment, mass of buckstays and with the pressure of combustion gases. Steam boilers of modern waste incinerators often have their supports welded on membrane walls and that result with significant increase of local stresses in such made supports. When it comes to the static calculation of the boiler, it is necessary to determine support reactions of the boiler, deflections of the boiler membrane walls and stress state in the critical zones. Because of the large number of pipes in the boiler membrane walls, it is practically impossible to discretize realistic geometry of the boiler by finite elements and perform necessary calculations. Since membrane wall structurally represents orthotropic plate, the theoretical approach of determining the elasticity modulus for membrane and bending stiffness of the structural orthotropic plate is going to be presented in this paper. After determining equivalent modulus of elasticity of the reduced plate, it will be possible, using finite elements for orthotropic plate, to perform the above mentioned static calculations of the steam boiler.

Significant researches in the field of structural orthotropic plates were made by H. J. Huffington [1]. Expressions for different forms of structural orthotropic plates can be found in the literature [2,3,4]. The method for homogenization of the boiler membrane wall [5,6,7] enables to consider the boiler as one constructional assembly on which it is possible (along with the above mentioned) to analyze the effects of thermal dilatation and buckling of membrane walls.

2. Elasticity constants of structural orthotropic plate for bending load

- Modulus of elasticity in direction perpendicular to the axis of membrane wall pipe (E_y^b):

In case of bending of membrane wall around the axis parallel with the membrane wall pipe axis, approximately the membrane wall pipe, with respect to membrane wall tape, can be considered as rigid body (Figure 1). In order to find an expression for modulus of elasticity E_y^b, the static beam model with clamped support on the one side, loaded with continuous loading is going to be analyzed.

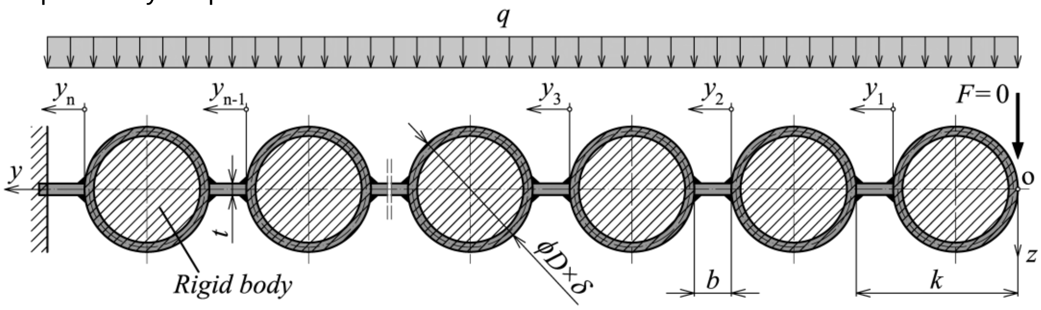

Figure 1. Geometric model for determination of equivalent modulus of elasticity E_y^b for bending load of the boiler membrane wall

According to the Engesser's theorem, the partial derivation of body's complementary energy of deformation with respect to any force, gives the displacement at the location of force as well as on the direction of force. As potential energy of deformation is equal to the complementary energy for a linear-elastic body, according to the Castigliano's theorem [8] it follows

$$\frac{\partial U}{\partial F} = w\,, \tag{1}$$

where U is the potential energy of elastic deformation of membrane wall according to the Figure 1, which has a unit width, and F is a fictive force which is going to be used for determining of the displacement w in the direction of the z axis.

If the pipes of the membrane wall are considered as ideally rigid, total potential energy of elastic deformation is equal to potential energy of elastic deformation of membrane tapes. To simplify the problem, the part of potential energy of elastic deformation which refers to shear stresses at bending caused by forces, will be neglected. According to acquired assumptions, total potential energy of elastic deformation of membrane wall can be calculated using the expression

$$U = \frac{1}{2EI_t}\sum_{\mathrm{i}=1}^{\mathrm{n}}\int_0^b M(x_\mathrm{i})^2 \mathrm{d}y_\mathrm{i}\,, \tag{2}$$

where:

E - modulus of elasticity for the material and calculating temperature of the membrane wall,

I_t - moment of inertia for bending axis of cross section of membrane tape with a unit width,

$M(x_\mathrm{i})$ - the distribution function of bending moments on the i-th membrane tape.

According to the expression (1), the deflection of the end of membrane wall for place of applied force $F = 0$ is

$$w = \left(\frac{\partial U}{\partial F}\right)_{F=0} = \frac{1}{EI_t}\sum_{\mathrm{i}=1}^{\mathrm{n}}\int_0^b M(x_\mathrm{i})\cdot\frac{\partial M(x_\mathrm{i})}{\partial F}\mathrm{d}y_\mathrm{i}\,. \tag{3}$$

If $k = b + D$, then the expression (3) can be written as

$$w = \frac{q}{8\cdot E\cdot I_t}\cdot\sum_{\mathrm{i}=1}^{\mathrm{n}}(\mathrm{i}\cdot k)^4 - (\mathrm{i}\cdot k - b)^4\,. \tag{4}$$

Moment of inertia for cross section of the membrane tape, with a unit width, can be calculated according to the expression

$$I_t = \frac{t^3}{12}\,. \tag{5}$$

Deflection for the structural orthotropic plate with the length $\mathrm{n}\cdot k$ and a unit width, clamped on the one end and loaded with continuous loading q, can be calculated according to the expression

$$w = \frac{q\cdot(\mathrm{n}\cdot k)^4}{8\cdot E_y^\mathrm{b}\cdot I_h}\,, \tag{6}$$

where:

E_y^b - modulus of elasticity of structural orthotropic plate, perpendicular to the pipes of membrane wall,

I_h - moment of inertia for bending axis for cross section of reduced orthotropic plate with a unit width.

Moment of inertia for cross section of structural orthotropic plate can be calculated according to the expression

$$I_h = \frac{h^3}{12}\,, \tag{7}$$

where h is the thickness of the structural orthotropic plate which can be calculated according to the expression [7]

$$h = \sqrt{\frac{3\cdot\pi}{16\cdot D\cdot k}\left(D^4 - (D - 2\cdot\delta)^4\right) + \frac{(k-D)\cdot t^3}{D\cdot k}}\,. \tag{8}$$

From the equality of the deflections of membrane wall (4) and structural orthotropic plate (6), modulus of elasticity E_y^b of structural orthotropic plate can be obtained or the axis perpendicular to membrane wall pipe

$$E_y^\mathrm{b} = E\cdot\left(\frac{t}{h}\right)^3\cdot\frac{(\mathrm{n}\cdot k)^4}{\sum_{\mathrm{i}=1}^{\mathrm{n}}(\mathrm{i}\cdot k)^4 - (\mathrm{i}\cdot k - b)^4}\,. \tag{9}$$

It can be noticed that modulus of elasticity E_y^b depends on the number of pipes n in membrane wall.

- Modulus of elasticity in direction parallel with membrane wall pipes (E_x^b):

Modulus of elasticity of structural orthotropic plate in direction parallel with membrane wall pipes can be calculated using the expression [7]

$$E_x^\mathrm{b} = \frac{E}{k\cdot h^3}\left[\frac{3\pi}{16}\left(D^4 - (D - 2\cdot\delta)^4\right) + (k - D)\cdot t^3\right]. \tag{10}$$

- Poisson's ratios:

Poisson's ratio ν_{xy}^b is equated with Poisson's ratio of membrane wall material, while Poisson's ratio ν_{yx}^b can be calculated from a known expression [8] which connects elasticity constants for perpendicular material axis

$$\nu_{yx}^{\mathrm{b}} = \nu_{xy}^{\mathrm{b}} \cdot \frac{E_y^{\mathrm{b}}}{E_x^{\mathrm{b}}} \,. \qquad (11)$$

- Shear modulus:

Shear modulus G_{xy}^{b} can be approximately calculated by expression [9]

$$G_{xy}^{\mathrm{b}} \approx \frac{\sqrt{E_x^{\mathrm{b}} \cdot E_y^{\mathrm{b}}}}{2 \cdot \left(1 + \sqrt{\nu_{xy}^{\mathrm{b}} \cdot \nu_{yx}^{\mathrm{b}}}\right)} \,. \qquad (12)$$

3. Elasticity constants of structural orthotropic plate for membrane load

- Modulus of elasticity in direction perpendicular to the axis of membrane wall pipe (E_y^{m}):

Modulus of elasticity of structural orthotropic plate, for membrane load in direction perpendicular to membrane wall pipes, will be determined using Castigliano's theorem. According to Figure 2, the displacement of point A, by a unit length of membrane wall, can be calculated by expression

$$v_\delta = \frac{\partial U}{\partial F_{\mathrm{A}}} \,. \qquad (13)$$

Since this is static undetermined problem (Figure 2), firstly, it is necessary to determine, inner forces in the section A.

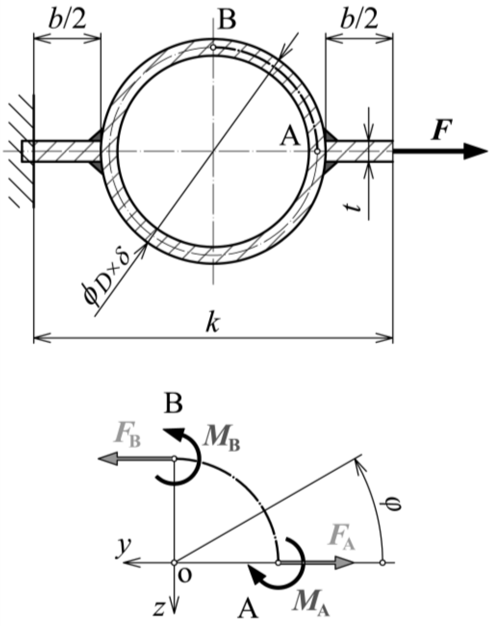

Figure 2. Geometric model for determination of equivalent modulus of elasticity E_y^{m} for membrane load of steam boiler membrane wall

This will be solved using theorem of minimum total potential energy of elastic deformation, using expression

$$\frac{\partial U}{\partial M_{\mathrm{A}}} = 0 \,. \qquad (14)$$

Potential energy of elastic deformation can be calculated using expression

$$U = \frac{2}{E \cdot I_\delta} \int_0^{\pi/2} M(\varphi)^2 \cdot R \,\mathrm{d}\varphi \,, \quad R = \frac{D-\delta}{2} \,, \qquad (15)$$

where:

I_δ - moment of inertia, for bending axis, for cross section of the membrane pipe with a unit width,

$M(\varphi)$ - the distribution function of bending moments.

Bending moment with respect to coordinate φ, according to Figure 2, is

$$M(\varphi) = F_{\mathrm{A}} \cdot R \cdot \sin\varphi - M_{\mathrm{A}} \,, \qquad (16)$$

where is $F_{\mathrm{A}} = 0{,}5 \cdot F$. Combining expressions (15) and (16), it is necessary to partially derived (15) according to (14)

$$\frac{\partial U}{\partial M_{\mathrm{A}}} = -\frac{4}{E \cdot I_\delta} \int_0^{\pi/2} \left(F_{\mathrm{A}} \cdot R \cdot \sin\varphi - M_{\mathrm{A}}\right) \cdot R \,\mathrm{d}\varphi = 0 \,. \qquad (17)$$

After integrating, bending moments can be obtained

$$M_{\mathrm{A}} = -\frac{2 \cdot F_{\mathrm{A}} \cdot R}{\pi} = -\frac{F \cdot R}{\pi} \,. \qquad (18)$$

The displacement of point A of membrane wall pipe in direction of y axis, according to the expression (13) is

$$v_\delta = \frac{4}{E \cdot I_\delta} \cdot \int_0^{\pi/2} M(\varphi) \cdot \frac{\partial M(\varphi)}{\partial F_{\mathrm{A}}} \cdot R \,\mathrm{d}\varphi \,. \qquad (19)$$

Bending moments are obtained if (18) is inserted into (16)

$$M(\varphi) = F_{\mathrm{A}} \cdot R \cdot \left(\sin\varphi + \frac{2}{\pi}\right) . \qquad (20)$$

The expression (20) should be combined with expression (19), and after derivation and integration, the displacement of point A of membrane wall is obtained by unit width of membrane wall,

$$v_\delta = \frac{4 \cdot F_{\mathrm{A}} \cdot R^3}{E \cdot I_\delta} \left(\frac{\pi}{8} - \frac{1}{\pi}\right) . \qquad (21)$$

Since $F_{\mathrm{A}} = \frac{F}{2}$, $R = \frac{D-\delta}{2}$ and $I_\delta = \frac{\delta^3}{12}$ the expression (21) can be written as

$$v_\delta = \frac{3 \cdot F}{E} \cdot \left(\frac{D}{\delta} - 1\right)^3 \cdot \left(\frac{\pi}{8} - \frac{1}{\pi}\right). \qquad (22)$$

Extension of membrane tape, by unit width of membrane wall, loaded with force can be calculated using expression

$$v_t = \frac{F \cdot b}{E \cdot t}. \qquad (23)$$

Extension of membrane wall, by unit width of the wall, in direction perpendicular to the axis of membrane wall pipe, can be calculated using expression

$$\begin{aligned} v &= \mathrm{n} \cdot (v_\delta + v_t) \\ &= \frac{\mathrm{n} \cdot F}{E} \cdot \left(3 \cdot \left(\frac{D}{\delta} - 1\right)^3 \cdot \left(\frac{\pi}{8} - \frac{1}{\pi}\right) + \frac{b}{t}\right) \cdot \end{aligned} \qquad (24)$$

where membrane wall consists of n pipes. Extension of the structural orthotropic plate with the length $\mathrm{n} \cdot k$ and a unit width, clamped on the one end and loaded with force F can be calculated according to the expression

$$v = \frac{F \cdot k \cdot \mathrm{n}}{E_y^{\mathrm{m}} \cdot h}, \qquad (25)$$

where:

E_y^{m} - modulus of elasticity of structural orthotropic plate, perpendicular to the pipes of membrane wall,

h - thickness of structural orthotropic plate which can be calculated by expression (8).

From the extension equation of membrane wall (24) and structural orthotropic plate (25), the modulus of elasticity E_y^{m}, for axis perpendicular to membrane wall pipes, can be calculated

$$E_y^{\mathrm{m}} = \frac{k \cdot E}{h \cdot \left[3 \cdot \left(\frac{D}{\delta} - 1\right)^3 \cdot \left(\frac{\pi}{8} - \frac{1}{\pi}\right) + \frac{b}{t}\right]}. \qquad (26)$$

- Modulus of elasticity in direction parallel with membrane wall pipes (E_x^{m})

Modulus of elasticity of structural orthotropic plate, in direction parallel with membrane wall pipes can be calculated according to the expression [7]

$$E_x^{\mathrm{m}} = \frac{E}{k \cdot h}\left[\frac{\pi}{4} \cdot \left(D^2 - (D - 2 \cdot \delta)^2\right) + (k - D) \cdot t\right]. \qquad (27)$$

- Poisson’s ratios:

Poisson's ratio ν_{xy}^{m} is equated with Poisson's ratio of membrane wall material, while Poisson's ratio ν_{yx}^{m} can be calculated from a known expression [8] which connects elasticity constants for perpendicular material axis

$$\nu_{yx}^{\mathrm{m}} = \nu_{xy}^{\mathrm{m}} \cdot \frac{E_y^{\mathrm{m}}}{E_x^{\mathrm{m}}}. \qquad (28)$$

- Shear modulus:

Shear modulus G_{xy}^{m} can be approximately calculated by expression [9]

$$G_{xy}^{\mathrm{m}} \approx \frac{\sqrt{E_x^{\mathrm{m}} \cdot E_y^{\mathrm{m}}}}{2 \cdot \left(1 + \sqrt{\nu_{xy}^{\mathrm{m}} \cdot \nu_{yx}^{\mathrm{m}}}\right)}. \qquad (29)$$

4. Conclusion

Acquired expressions enable fast and simple determination of equivalent elasticity constants of membrane wall as structural orthotropic plate. There are also opened possibilities of more detailed structural analysis of steam boiler, e.g. determining the reactions in supports, dimensioning of buckstays, determination of thermal extension influence, determination of deflection of the membrane walls as well as buckling of the membrane walls.

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FORWARD EXTRUSION OF BI-METALLIC COMPONENTS

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Abstract
Bi-metallic extrusion is relatively novel metal forming operation which makes possible to fabricate metallic workpieces composed of two or even more materials. In this way product with different properties at its different sections can be produced. Industrial application of this process is still relatively limited which can be partially attributed by the scarcity of technological information and knowledge related to bi-metallic deformation.
Current paper outlines main characteristics and models of this technology. Experimental investigation of forward extrusion of Al (sleeve) and Cu (core) materials is elaborated.

Keywords:
Forward bi-metallic extrusion, load estimation, Al/Cu billet

1. Introduction

Bi-metallic extrusion is a metal forming operation where initial billet consists of two different metallic materials which are then together, simultaneously, cold extruded. In this way final product is manufactured, which has different properties (mechanical, electrical, thermal, magnetic, frictional…) at different workpiece sections. This kind of metal forming operations makes it possible to fabricate workpieces with optimal combination of desired properties which are incorporated into final product. For instance, aluminium/steel billets combine the strength of steel with electrical conductivity and corrosion resistance of aluminium. It was stated in [1] that bi-metallic Al/Cu rod is 30-40% cheaper than pure Cu rod, by realizing the same function.
Possible combination of metals that can be employed in bi-metallic extrusion is relatively large, which enables numerous combinations in this kind of operation.
The main challenges in planning and performing of bi-metallic components are a) bonding between two metals and b) (non)uniform deformation of both materials during deformation. Only workpieces with strong metallurgical bond between two metals and with dimensional stability, i.e. constant ratio of the sleeve to core material thickness can be considered as a sound bi-metallic component.

Although industrial application of bi-metallic components is still limited, the recent achievements in research and development of this forming alternative promise its broader commercial implementation in near future.

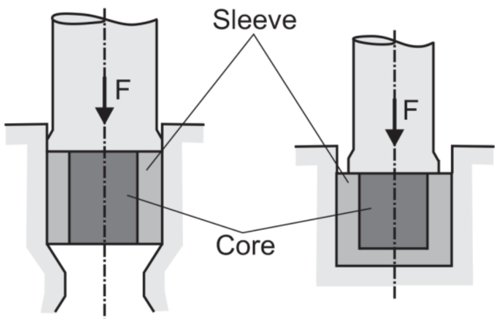

Figure 1. Forward and backward bi-metallic extrusion

Current paper presents experimental investigation of bi-metallic forward extrusion. Combination of Al/Cu was employed. Load-stroke characteristics and material flow of both materials have been studied.

2. Models of bi-metallic extrusion

Beside forward and backward bi-metallic extrusion, other models are also feasible, such as tube extrusion, radial and combined extrusion, etc. Still, most frequently implemented are forward and backward extrusion (Fig. 1.). In both cases sleeve material can be softer or harder than core material. Also, shape and dimensions of sleeve and core can vary. Core and sleeve material combination and their initial dimensions have direct impact on the process development and component properties. Possible shape of sleeve/core assembly is often used as important parameter in optimization of bi-metallic extrusion. According to [2] the main influential factors in bi-metallic extrusion are: reduction in area, semi-cone angle, length of the load, friction factor, ratio of core and sleeve radius (R_c/R_0) and ratio of core and sleeve flow stress.
As mentioned before, bond between both metals is important indication and significant requirement for proper bi-metallic component. It was concluded by FE analysis and by experimental investigation in forward bi-metallic extrusion of Al/Cu component, that optimal die angle is 25°. In this case best bond

i.e. high shear strength between two metals is achieved [3].
Backward bi-metallic extrusion was numerically and experimentally studied in [4]. Focus was placed on forming load and material flow during deformation. Numerically and experimentally obtained results show fair agreement. In Fig. 2 meridian cross-section of bi-metallic workpiece obtained by experimental and by FE analysis are given. As it can be seen, two pictures resemble to each other to great extent.
Beside numerical analysis and experimental investigation, bi-metallic extrusion has been studied also by Upper Bound and SLAB method. In [5] bi-layered bearings produced by backward extrusion was analyzed by upper Bound method. Chosen velocity field suggested by experiment gave good results for force and for the evolution of workpiece geometry.
Paper [6] reports work into a extrusion of bi-metallic tubes. Analysis was performed by SLAB method. Different die/billet geometries were varied. Analytical results were compared with the results obtained experimentally and good agreement was found.

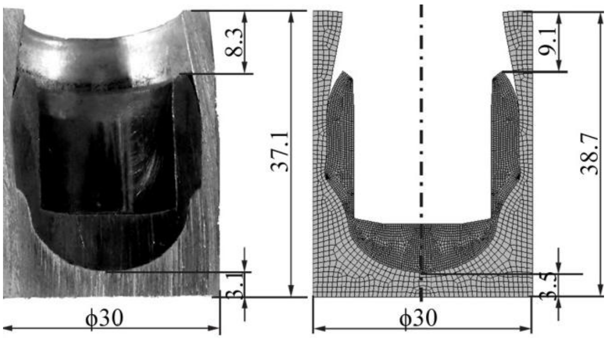

Figure 2. Meridian cross section of backward extruded workpiece obtained by experiment and FE simulation [4]

At FTN - University of Novi Sad broader investigation on bi-metallic extrusion has been carried out. Backward and forward extrusion have been experimentally and numerically elaborated so far. Further work on this issue is directed at exploring the potential of different materials and shapes for bi-metallic extrusion.
Current paper elaborates the process of forward extrusion of Al/Cu assembly with the focus on load development and material flow during extrusion.

3. Experimental procedure

Billets for forward extrusion were combined of softer sleeve (aluminium) and harder core (copper).

Stress – strain curve of both materials were obtained by Rastegaev test [7]:

$$\sigma_{Cu} = 315 \cdot \varphi^{0.54} \text{ [MPa]} \quad (1)$$
$$\sigma_{Al} = 127.5 \cdot \varphi^{0.2} \text{ [MPa]} \quad (2)$$

Separate sleeve and core as well as assembled billet are shown in figure 3.

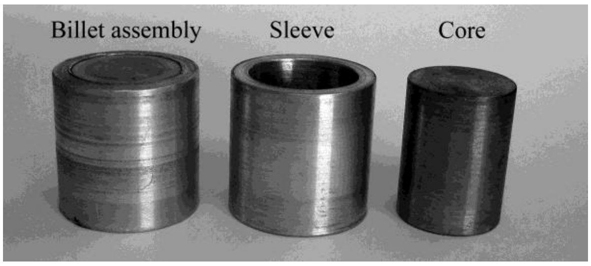

Figure 3. Billet assembly, sleeve and core

Main dimensions of the billet in relation to the die are given in Fig. 4.

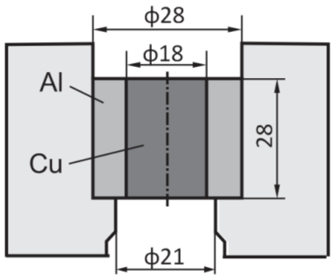

Figure 4. Billet dimensions in relation to the die

For experimental investigation special tooling has been designed and made (Figure 5.).

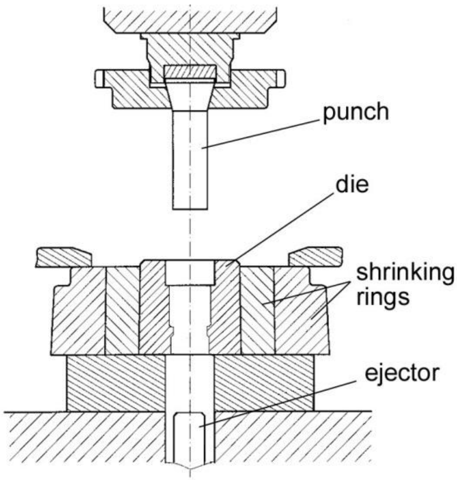

Figure 5. Tooling for bi-metallic forward extrusion

Lubrication during deformation was done by oil. Experiments were conducted on Sack & Kiesselbach hydraulic 6,3 MN press with the velocity of 0.2 mm/s.
Photograph of the experimental tooling is given in Fig.6.

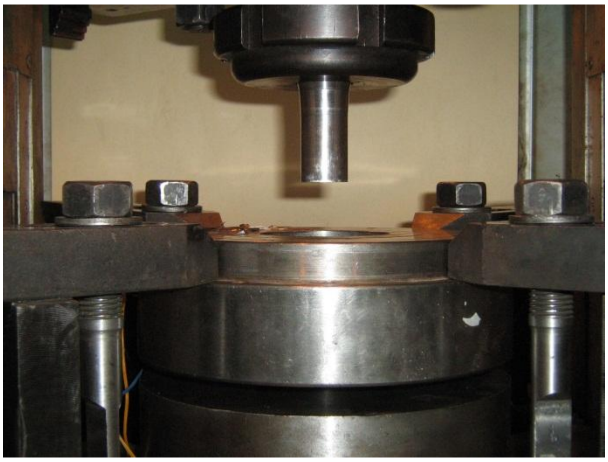

Figure 6. Photograph of the experimental tooling

During forward extrusion load – stroke diagram was recorded (Fig7).

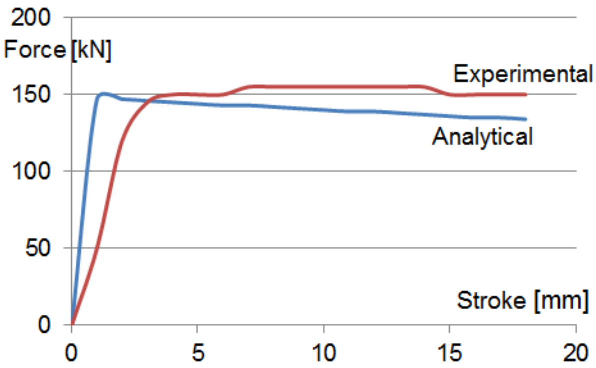

Figure 7. Force – stroke diagram

Beside experimental load, in Fig 7. analytically obtained load is presented as well. Calculation was performed by means of following expression 0:

$$F = A_0 \cdot K_{sr} \cdot \varphi \cdot \left(1 + \frac{\mu}{\alpha} + \frac{2}{3}\frac{\alpha}{\varphi}\right) + 4 \cdot \mu \cdot K_0 \cdot \frac{h_1}{D_0} A_0 \qquad (3)$$

Where:
A_0 – punch area
$K_{sr} = \frac{K_0 + K_1}{2}$, K_0 – effective stress at beginning of the process, K_1 – effective stress after material deformation
φ – logarithmic deformation, $\varphi = 2 \cdot ln \, {}^{D_0}/_{d_1}$
μ – friction coefficient
α – die angle
h_1 – billet's current height in the die (where D_0 = 28 mm)
D_0 – billet's initial diameter
d_1 – billet's extruded diameter

Equation (3) is valid for single material forward extrusion. In order to employ it in the case of bi-metallic extrusion, effective stress was calculated as average effective stress of two materials, by means of volume fraction:

$$K = \%V_{Al} \cdot K_{Al} + \%V_{Cu} \cdot K_{Cu} \qquad (4)$$

Where:
K – effective stress of bi-metallic composition,
K_{Al}, K_{Cu} – effective stress of aluminium and copper
$\%V_{Al}$, $\%V_{Cu}$ – volume fraction of each segment in bi-metallic billet.
Load – stroke diagram in Fig. 7. was obtained by employing fraction volume principle (4) in equation (3). Both K_{sr} and K_0 were calculated by using expression (4) for specific composition case illustrated in Figure 4 ($\%V_{Al}$ = 59% and $\%V_{Cu}$ = 41%).

4. Discussion of the results and conclusion

At the beginning of the process experimental and analytical load increases steeply but in further process development it remains almost constant or even slowly decreases. This is co called steady – state phase of extrusion.
It is evident from the Fig 7. that there is good agreement between experimental load and load approximately calculated by (3) and (4).
In Fig 8. billet, extruded bi-metallic component as well as the meridian cross section of this component are shown.

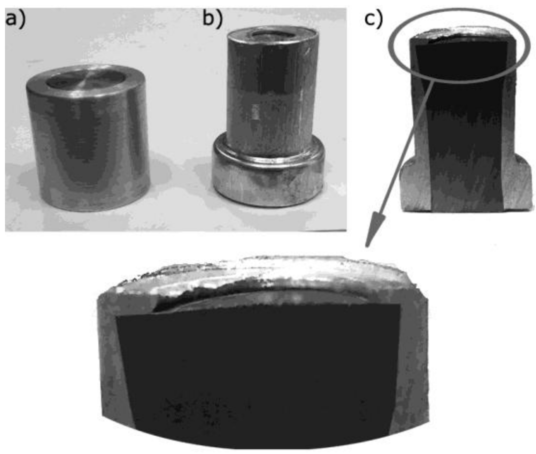

Figure 8. Extruded component and its meridian cross section: a) billet, b) workpiece, c) cross section

From Fig. 8c it is obvious that outer Al-sleeve deforms easier than harder Cu-core. Sleeve even overlaps the top of the core, which means that Al moves faster than Cu core during deformation.
Distribution of sleeve thickness and core diameter along the workpiece was measured as well. For instance, at the distance y = 9 mm core thickness is 2.89 mm and core diameter is 15.21 mm (please note that the scale for vertical axes "*d*" and "*s*" are different). Minimal core diameter and maximal sleeve thickness occur at the die entrance whereas maximal core diameter and minimal

sleeve thickness takes place at the extruded end of the billet (Fig. 9.).

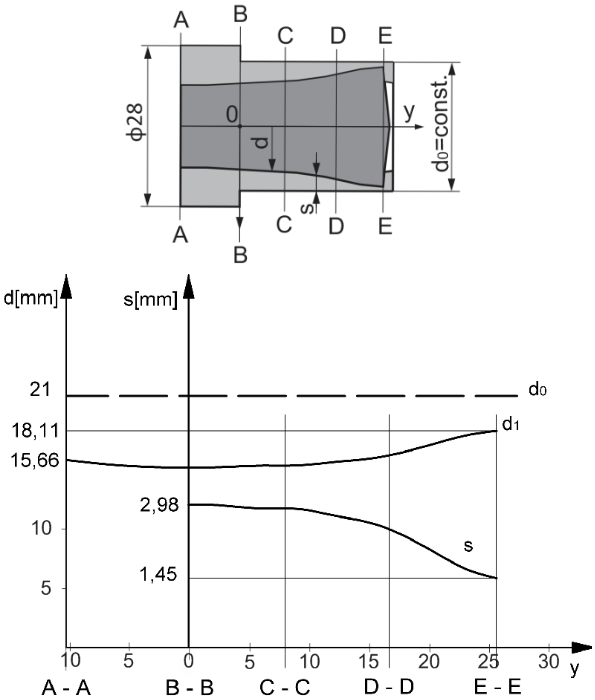

Figure 9. Thickness of Cu-core and Al-sleeve at different cross-sections

As it can be seen from Fig. 8b, 8c and 9., dimensional stability of the core/sleeve is relatively satisfactory. The highest degree of core radial deformation takes place at the exit from the die (B-B). In order to achieve even higher level of dimensional stability, optimization of the billet geometry and process data are necessary. Exact *d* and *s* values at various cross-sections are given in Table 1.

Table 1. Measured sleeve thickness and core diameter at different cross-sections

	A - A	B - B	C - C	D - D	E - E
d	15.66	15.04	15.21	16.36	18.11
s	-	2.98	2.89	2.32	1.45

Although present work is a kind of preliminary study, it provides a solid basis for further, more detailed theoretical, numerical and experimental investigation of bi-metallic forward and backward extrusion.
Further work on current issue should include:
- Optimization of the process (die and punch shape, billet geometry, material combination…)
- Creation of novel bimetallic models
- Development and application of new analytical, numerical and experimental methods to investigate bimetallic extrusion
- Nature of the created bond between two materials and the way how to influence it
- Amount of shear stress between two materials
- Search for further possible application of bimetallic components in industry

5. Acknowledgements

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SOME EXAMPLES OF VSR METHODOLOGY INDUSTRIAL APPLICATION

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Abstract
In this paper the implementation procedure for vibratory stress relief (VSR) on several models of welded construction for the needs of specialised industry is presented. With vibratory relaxation process application at large constructions it is usually necessary to release residual stresses in the structure with the realization of dimensional stability of the pieces, i.e. preventing further dimensional changes in terms of allowed geometric tolerance after machining process or after their transportation to the destination for assembling. To implement the procedure it is inevitable to define the parameters of vibration, perform the installation of sensors for quantifying and monitoring of changes in the structure during vibratory relaxation procedure. Detailed monitoring of the process with measurement sensors is performed on each construction with stress or/and dimensional control during and after the process implementation on examples.

Keywords:
VSR - Vibratory Stress Relief, welded construction, residual stress, dimensional stability.

1. Introduction

There are two kinds of residual stresses in the welding technology: *forced*, resulting from assembling of parts with free ends, where the effect is present only on the observed parts, and *reactive* which occurs in parts whose ends are trapped and they are prevented from forming, and transferred internal stresses in the whole welded structure. Residual stresses, formed in above mentioned ways, are multi-axial and combined with other stresses or low temperatures could create conditions for the occurrence of brittle fracture.

In the past 60 years, VSR has grown from a little known area to respective primary process, which was established as an alternative to heat treatment of castings, manufactures, pieces requiring additional machining, and non-metallic materials. Effects of reduction of residual stresses in various previous studies have a wide range from 20% to 95%. Effect of vibratory relaxation method depends on many factors, such as type of construction, structural dimensions, weight and rigidity of the structure, characteristics of VSR equipment, suspension of construction, etc. The procedure of residual stress relieving on structures can be done in several ways, the best results can be achieved with heat annealing treatment, but due to limitations on the dimensions of structures that need to be treated alternative methods have been developed. One of these alternative procedures is vibratory relaxation process, [1,2].

2. VSR treatment of welded flanges

This chapter presents brief method and results of performing the vibratory relaxation of residual stresses in the zone of welded flanges on vertical tanks with floating roof, Figure 1. Vertical tanks with floating roof for liquid fuel storage are welded steel structures of large dimensions and as such are usually subjected to the treatment of residual stresses relaxation. Measurements of residual stress are made i.e. the definition of "zero state" as well as measurement of changes in residual stress caused by vibratory relaxation, which was performed in order to eliminate or decrease the size of residual stresses. The process of performing VSR technology (after welding) at the connection point of tank hole and tank flange, and performance of monitoring technology took place at the following stages: preliminary dynamic analysis of tank structural construction and flange, preparation and installation of measuring gauges, detailed measurements of residual stresses using the ''hole drilling'' method, monitoring of changes in stress during VSR procedure, positioning of force exciter at two orthogonal locations at flange, monitoring the process of relaxation, post-processing of data, measurement of residual stresses after applied procedure. Only a short view will be presented here without numerical dynamic analysis and other data in very detail.

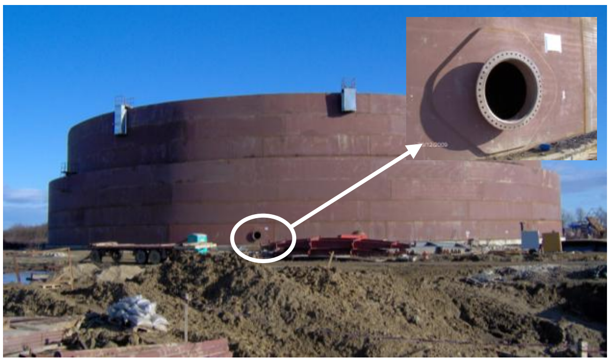

Figure 1. Flange on the tank of 85.000 m^3 storage capacity, JANAF, Sisak

Residual stress relaxation, using the VSR is carried out at three flanges on the tank, which have the same geometrical properties. Flanges are attached to the sheet metal by welding which is performed by specially projected technology. Flange is a light opening ∅ 750 mm and with a thickness of 23 mm, and a tank thickness of 31 mm in the zone of the flange. On the basis of specific scientific parameters, the geometrical characteristics of flanges with sheets, and the geometry and the quantity of welds, it can be considered that places of weld joints of the flange and tank sheets are with greatest concentrations of stresses. VSR equipment of Meta-Lax type, with working frequency range 0-100 Hz and 20-100% eccentricity is used. The equipment consists of the exciter force transducer and acquisition devices. With the force exciter a "scanning" of the construction of the first flange is conducted, which showed "sensitivity" of structure in the range of 45-80 Hz. Therefore, the applied frequencies were in that range, lasting 30-40 minutes. Based on these indicators, parametric procedures are implemented for each flange. Residual stress measurements are derived in order to determine the parameters at the beginning and end of the process, Figure 2. Measurements of residual stress were conducted using the system for automatic determination of residual stresses using strain gauges "MTS-3000" where used ''hole drilling'' method defined by ASTM 837-01, [3]. Data acquisition was performed using a measurement system "Spider 8-30'', rosette measuring gauges, and software "Catman 5.0 Professional''.

Figure 2. Residual stress measuring points

Strain gauges are installed on the following flange measuring places: Z1 - place to measure the residual stress before VSR treatment, Z2 - place to measure the residual stresses after VSR treatment, M1 to M6 - places to measure the change of stresses during the vibratory relaxation for the two orthogonal directions on the flanges No. 1 to 3, *(not presented in details because of the paper extension)*.

Measurement appointed to the fact that the highest value of principal stress before treatment vibratory relaxation is in the weld zone. All the measured residual stresses are of tensile character. All three flanges are treated in the same conditions, with the same positions of the vibrator, where the rate varied from ~ 60-90 Hz. Treatment of each flange with Meta-Lax equipment is done in two ortogonal directions, Figure 3.

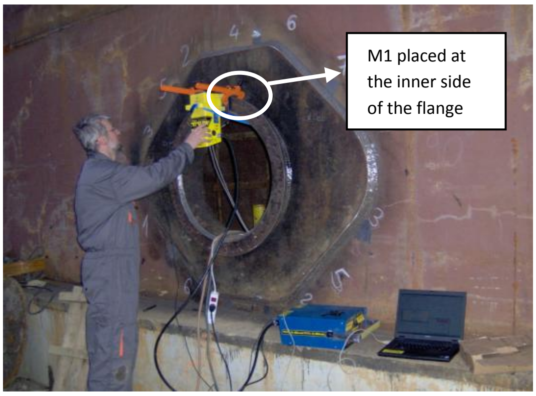

Figure 3. Vibratory treatment

The change in stress at the measuring point M1 occurred as a result of vibration is presented in Figure 4.

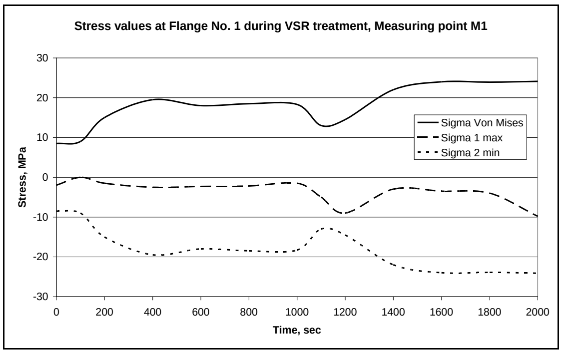

Figure 4. Stress values, flange No. 1 Measuring point M1

Measured strains at all measuring points, during VSR process are negative, indicating that the initial stress was tensile in character which is common in welded joints. Comparative values of the measured changes in residual stresses before and after vibratory relaxation are given in Table 1.

Table 1. Comparative results of measurement of residual stresses

Sample	Meas. point	σ_1 max [MPa]	σ_2 min [MPa]	σ_{ekv}^M [MPa]	σ_{ekv}^T [MPa]
Before VSR	Z1	132	109	122	132
After VSR	Z2	104	84	95	104

Symbols used in Table 1 are: σ_{1max} - max. main stress, σ_{1max} - min. main stress, σ_{ekv}^{M} - equivalent stress according to the Von-Mises hypothesis, σ_{ekv}^{T} - equivalent stress according to the Tresca hypothesis. The comparison of measurement results of residual stress relaxation before and after the relaxation shows that the reduction of residual stress, using the vibratory relaxation of the tank is in the range of 18-28%.

3. VSR treatment of welded grid structures

The next example of VSR process application is grid welded type of construction, Figure 5. Geometrical characteristics are: overall dimensions 6300 x 3100 x 600 mm, with embedded profiles 160x80x4; 160x120x6; sheet thickness of 30, 25, 15, 10, and 8 mm, with total weight about 2400 kg. The aim of the VSR technology application in this case is to reach dimensional stability of the component in requested tolerance value. The procedure of vibratory relaxation treatment involves placing the structure on the corresponding supports schedule, and excitation of the structure corresponding to vibratory frequencies and mode shapes.

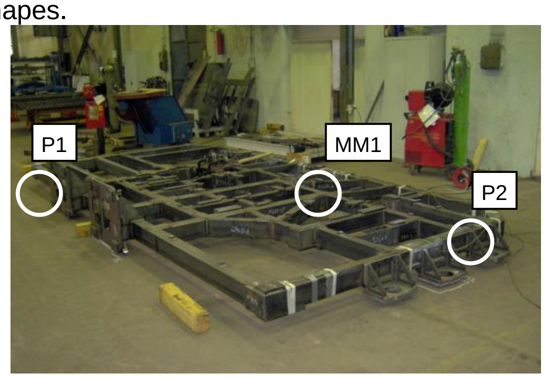

Figure 5. Treatment of the construction 1

In terms of procedure monitoring the corresponding sensors are used: strain gauges LY-11 with the aim of measuring strain changes in the selected places of the structure, Figure 6, acceleration sensors Metrix and displacement transducers WA 100 and 200. Data acquisition was performed using the measurement system "Spider 8-55", and the results were processed using the software "Catman 5.0 Professional". For the monitoring of process the stroboscopic lamp DT-2259 is used.
For the vibratory excitation of the structure an electro-force inducer with step regulation is used. After a "scanning" of the construction the "sensitivity" of structure in the range of 20-30 Hz is appointed. Stress changes at the measuring point M1 is presented in Figure 7.
Displacement changes regarding the geometrical influence are presented in Figures 8 and 9.

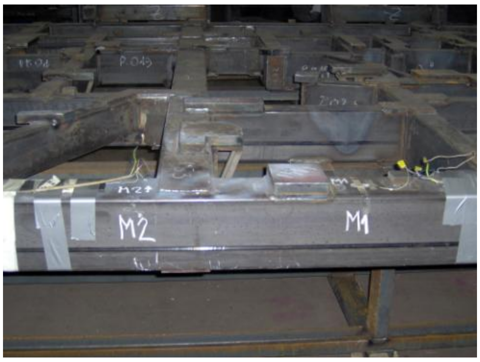

Figure 6. Strain gauges at the construction 1

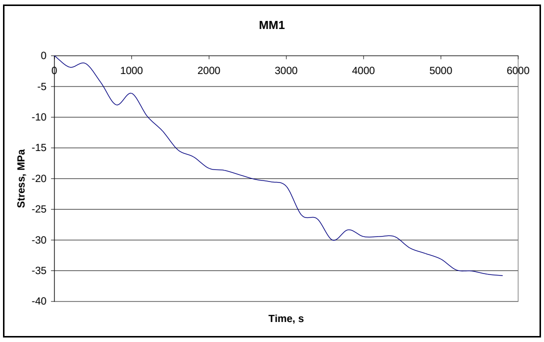

Figure 7. Stress changes during VSR of the construction 1

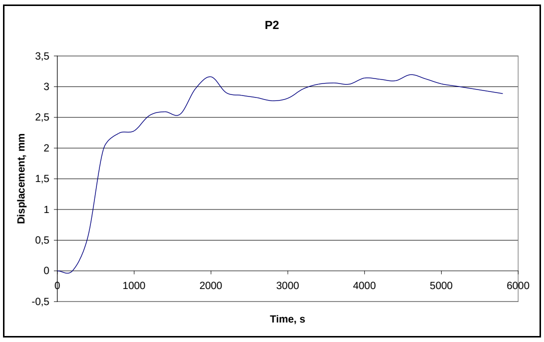

Figure 8. Displacement of the construction 1 (point P2)

The values of ''relative stress'' change are: -35,8 MPa and changes in geometry of points P1 and P2 are: -2.17 mm, +3.194 mm, respectively.

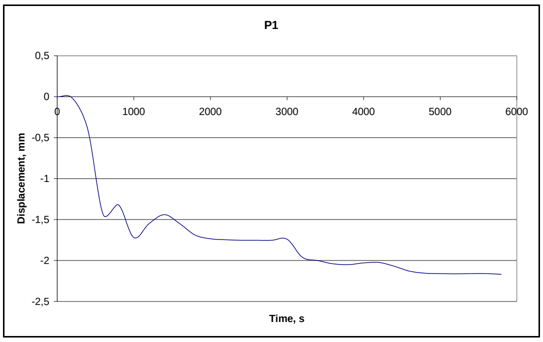

Figure 9. Displacement of the construction 1 (point P1)

In the same manner with the same goal of the dimensional changes, one more type of grid welded construction is treated. In this treatment of the construction 2, geometrical, frequency and other characteristics of this construction are accepted. Positions of measuring places M1 (strain gauge) and P1, P2 (displacement transducers) are selected for two locations at the construction, Figure 10.

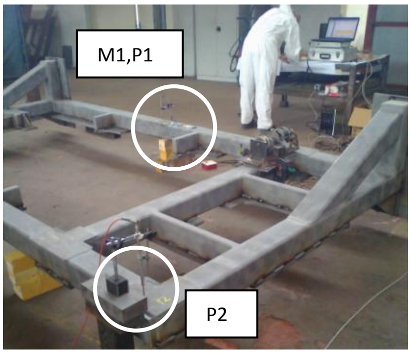

Figure 10. Treatment of the construction 2

After a "scanning" of the construction the "sensitivity" of structure in the range of 30-40 Hz is appointed. Stress changes at the measuring point M1 are presented in Figure 11.

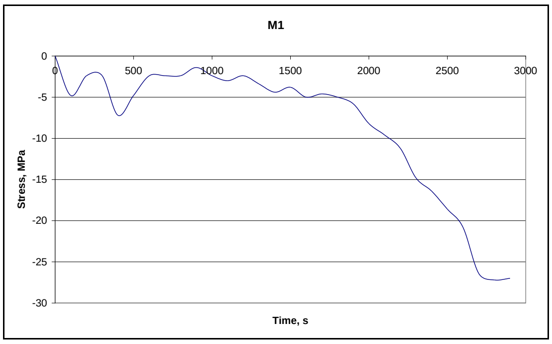

Figure 11. Stress values of the construction 2 (point M1)

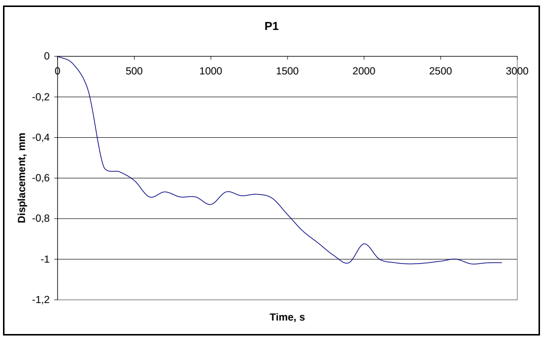

Figure 12. Displacement of the construction 2 (point P1)

Displacement changes regarding the geometrical influence on construction 2 are presented in Figures 12 and 13.

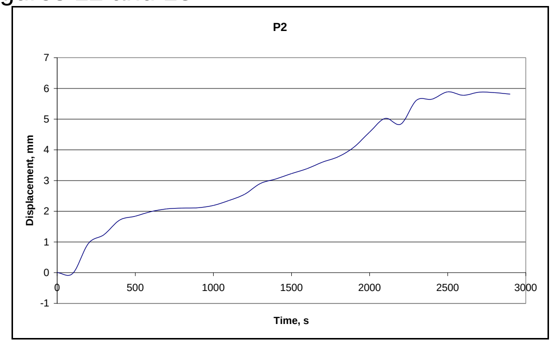

Figure 13. Displacement of the construction 2 (point P2)

The value of "relative stress" change is: -27 MPa and changes in geometry are: P1: -1,023 mm, P2: +5,875 mm.

4. Conclusion

In the above presented material it can be seen that VSR technology has a success as alternative method to the heat treatment for large constructions, but the effectiveness of the method is related to several crucial characteristics or parameters. Effect of vibratory relaxation method depends on many factors, such as type of construction, structural dimensions, weight and rigidity of the structure, characteristics of VSR equipment, suspension of construction, etc. Based on the results of measurement carried out after the application of vibratory relaxation procedure on both examples, it can be concluded that the application of treatment led to a change in stiffness of treated samples, and resulted in changing of stress state and geometry, i.e. the dimensional stability of treated samples. Changing the strain state of both structural and geometric changes at observed points clearly indicate their mutual relationship and the effect of treatment.

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NEW TECHNOLOGY FOR HARD MANUFACTURING OF SPECIAL WORMS

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Abstract
In order to manufacture high precision worm gears with variable pitch and cross section, we developed a new technology based on ultraprecision turning, which was tested on a HEMBURG ultrapecision lathe at DIRECT-LINE Kft. laboratory in Budapest. In this paper we will present the main theoretical and experimental aspects of this technology.

Keywords:
Gearing, Precision turning, roller transmission

1. Introduction

It is well known that processing of hardened steel with ultraprecision turning is considered as an alternative of grinding. Its use is increasingly common due to adjustment benefits. In our research we used this method for manufacturing special worms. Experimental research was done on a machine developed and manufactured by the company HEMBRUG AG.

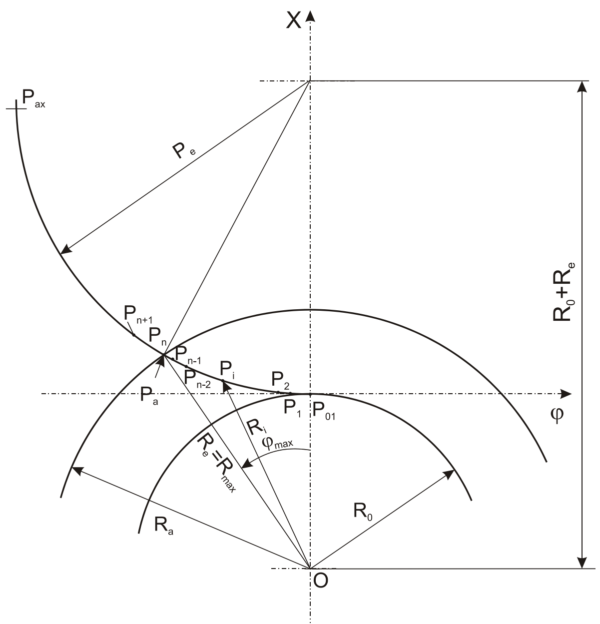
The advantages of high precision turning in comparison with grinding are:
- the material removal rate is higher, especially for the manufacturing of complex profiles and surfaces
- the used tool may have a much higher rigidity, while the contact surface is much smaller. Hence, the force normal to the surface is smaller.
- the hard processing of roller transmissions with ball screw is mainly possible with ultraprecision turning [MES 06]
- the possibility of using universal tools with defined geometry for processing complex profiles.

This technology also has environmental benefits because processing is performed in dry media thus, the resulting waste has a lesser impact on the environment. The superficial layer structure and surface roughness obtained in ultraprecision turning is very different from the surface morphology obtained by grinding [KUF 05].

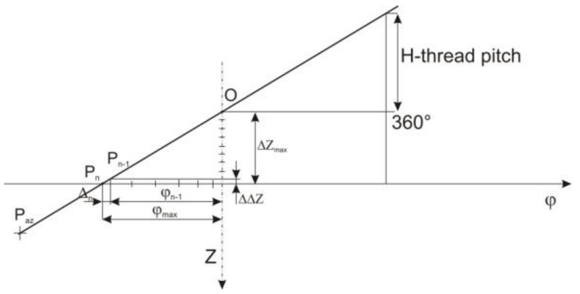
As a disadvantage of ultraprecision turning one could mention the necessity of stringent process control. The machined surface is obtained by a single peak of the tool, compared with abrasive cutting where several peaks are involved, and this single peak may break. However, with the development and deployment of CBN tools this disadvantage is increasingly rare.
In the following we will present some specific aspects of ultraprecision turning for the manufacturing of complex helical surfaces used in modern mechanical transmissions.

2. Special method for approximating the control curves

In the case of the special roller transmissions the main screw surfaces consist of three parts: the acceleration (the input), the central helical screw and that the deceleration (the output). The acceleration portion is necessary for obtaining the cheeping speed of the tool upon entry into helical channel of the pieces. If this entry portion is short, than helical surface pitch errors may occur. The deceleration portion is required to allow time to reduce the speed until the change of direction of travel takes place.
This is necessary to return the starting position for a new crossing. Figure 1 shows the method of calculation for the acceleration portion.



a) in plane X-φ,



b) in plane Z-φ

Figure 1. Approximation calculation of input portion

In Figure 1 we used the following notations:
- R0 - bottom half of the thread diameter of the circle;
- Re -entry area;
- H - thread pitch as Z axes ;
- Rn=Ra - external radius of thread

The calculation formulas are as follows:

$$\cos\varphi_{max} = \frac{R_{max}^{\ 2} + (R_{01}+R_e)^2 - R_e^{\ 2}}{2R_{max}(R_{01}+R_e)}$$
$$\varphi_{max} = \arccos\left(\frac{R_{max}^{\ 2} + (R_{01}+R_e)^2 - R_e^{\ 2}}{2R_{max}(R_{01}+R_e)}\right) \qquad (1)$$

$$\Delta Z_{max} = \frac{H\cdot\varphi_{max}}{360} \qquad (2)$$

The Δ Zmax area is divided into n equal parts

$$\Delta\Delta Z_{max} = \frac{\Delta Z_{max}}{n} \qquad (3)$$

Furthermore, after $\Delta\Delta$Zmax has been calculated, we chose one appropriate value according to the capabilities of the machine. Using this value we calculated Rmax with equation (4).

$$R_{max_{nou}} = \frac{2(R_{01}+R_e)\cos\varphi_{max\,nou} - \sqrt{4(R_{01}+R_e)^2\cos\varphi_{max\,nou}^{\ 2} - 4(R_{01}^{\ 2}+2R_{01}R_e)}}{2} \qquad (4)$$

Using the following values :

$$\varphi_{n\pm i} = \varphi_{max} - \frac{i\cdot\Delta\Delta z\cdot 360}{H}$$
$$\Delta\varphi = \varphi_i - \varphi_{i+1} \qquad (5)$$

$$R_i = \frac{2(R_{01}+R_e)\cos\varphi_i - \sqrt{4(R_{01}+R_e)^2\cos\varphi_i^{\ 2} - 4(R_{01}^{\ 2}+2R_{01}R_e)}}{2} \qquad (6)$$

This way, the X coordinates was determined:

$$X_i = 2R_i$$
$$i = 1..n+1 \qquad (7)$$

3. The pitch determination

$$\Delta X_{n-i} = R_{n-(i+1)} - R_{n-i} \qquad (8)$$

$$I_{n-i} = \frac{\Delta x_{n-i}360}{\Delta\varphi} \qquad (9)$$

4. Cutting depth determination

The cutting depth aM is an entering parameter, witch was used for determination of the limiting position of the tool peak (Fig.2).

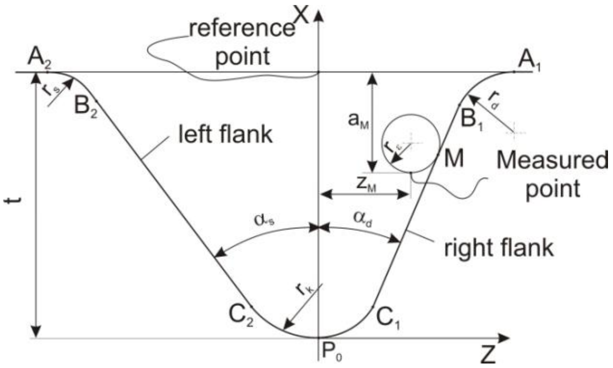


Figure 2. Determination the programming position of the tool peak

The ZM parameter (Fig. 2) was calculated with the expression :

$$Z_M = e + r_d\cdot\cos(\varphi) - r_\varepsilon\cdot\sin(\varphi) - r_d\cdot\sin(\varphi) \qquad (10)$$

Where:

$$\sin(\varphi) = \sqrt{1 - \left(1 - \frac{a_M}{r_\varepsilon + r_d}\right)^2} \qquad (11)$$

5. Determination of the channel profile using the 3D model of the machine part

For determination of the effective shape of the axial profile for the special worm a 3D model was employed (Fig.3).

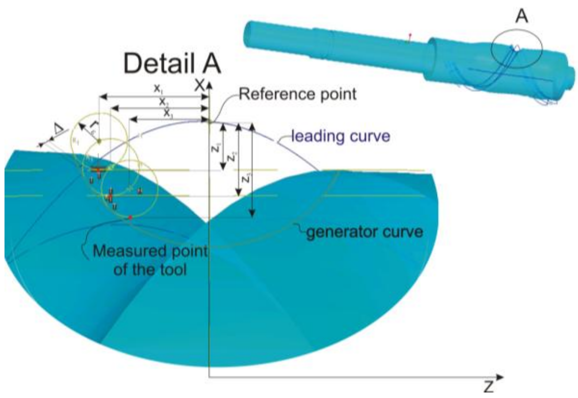


Figure 3. The axial profile of channel in 3D model

The axial section of the groove, as can be seen from Figure 3, can not be described with any simple geometry. To get the geometrical details needed for processing, a CAD program was employed. In order to determine the coordinates necessary for programming, we intersected the model with a series of planes parallel with the axes. The generating curve (axial section) represented by the green line in Figure 3, was obtained using the known radius r⍰ at the top blade. With the red color the measuring point of the tool is represented. The reference point is situated where the leading curve intersects the groove. The values X1 ... Xn and Z1 ... Zn were saved in a table that we used for machine programming and machining. The disadvantage of this method is that for every change in the depth of cut one must recalculate the coordinates that describe the groove section.

6. The strategy for material removing

For manufacturing the special helical channels with the ultraprecision machine tool, it is necessary to solve some specific aspects of material removing. For one special worm, having the axial profile presented in Figure 4, it necessary to realize a uniform distribution of pressures and chipping energy.

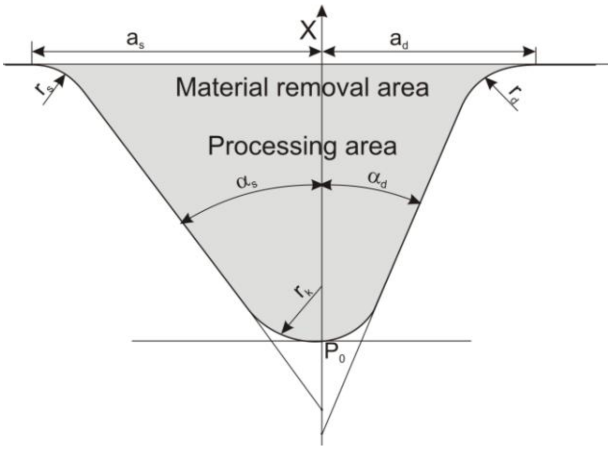


Figure 4. The axial section of a special worm

The material removing was divided in two phases: rough and smooth cutting, respectively.

6.1. Strategy for rough cutting

The input data required for processing is the leading curve guiding the channel. The strategy for rough material removal is achieved during several steps of travel from left to right (Fig. 5).

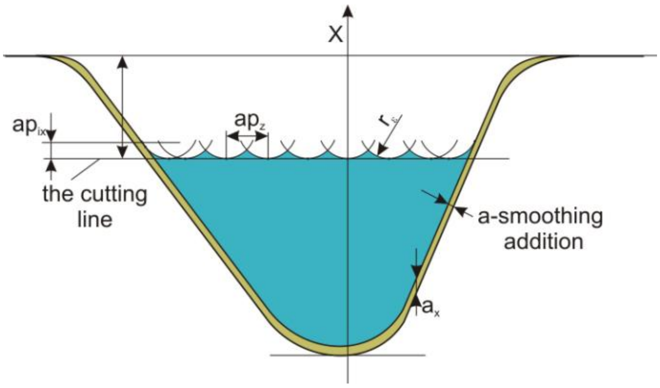


Figure 5. The strategy for rough material removing

The roughening profile was established as a function of the smoothing addition ax (Fig.5).
We can observe that during the initial stages, the active portion of the cutting blade cutting edge is higher in comparison to the following steps (Fig. 6).

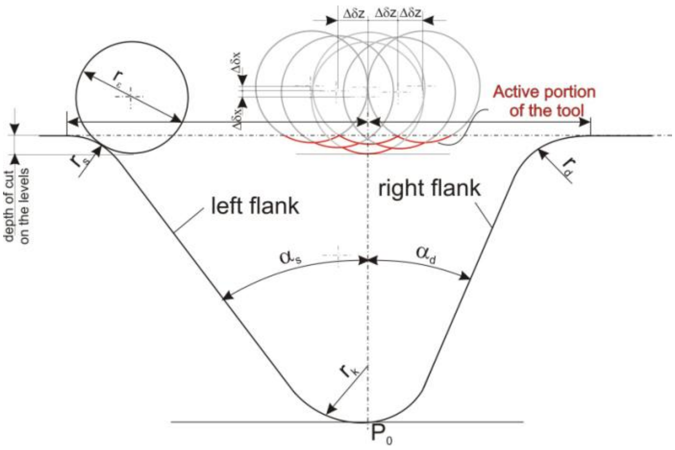


Figure 6. The distribution of chipping depths at first step.

6.2. Strategy for smooth cutting

The strategy for smooth removal of the material was established using the final profile of the worm channel taking into consideration the necessary surface roughing and shape precision (Fig.7).

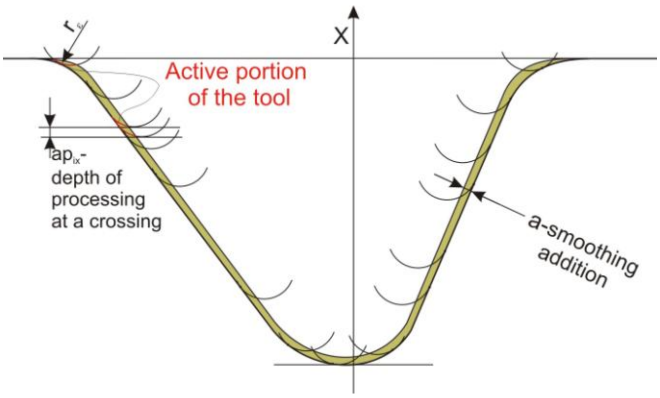


Figure 7. Strategie for smooth cutting

7. Conclusion

The high precision worms manufactured by ultra precision turning was compared with some worms realized by milling. It is concluded that it is possible to obtain higher quality for modern transmissions with rolling balls from the point of pitch, shape and surface roughness quality. The manufacturing time was a little bit longer, but taking in consideration the obtained quality, it is justified to further investigate and develop the proposed process. At the same time, we conclude that for serial production of drives with balls roller transmissions it is still necessary to solve a number of technological and economical problems.

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COMPARISON OF THE PARALLEL AND COUNTER FLOW HEAT EXCHANGER–THERMAL ANALYSIS

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Abstract
This paper presents thermal analysis of the recuperative, tube in tube, parallel and counter flow heat exchanger (PFHE and CFHE). Thermal analysis of heat exchangers was performed by varying the values of mass flow rate. The comparison of the relevant parameters for both heat exchangers is shown in table and the influence of the overall heat transfer coefficient is quantified. The higher efficiency of the counter flow heat exchanger with respect to the parallel flow heat exchanger is demonstrated.

Keywords: parallel and counter flow heat exchanger; thermal analysis, efficiency.

1. Introduction

In this paper, based on the First law of thermodynamics, the differential equations for the heat exchangers when stronger stream is also a warmer stream were set and computer program for calculating the temperatures of both streams along the surfaces of the heat exchangers and the exchanged heat flow rate as a function of local value of the heat exchanger area were developed. The calculations of ten different cases for ten working points of heat exchangers are conducted and heat exchangers are dimensioned. The temperature distribution and local heat transfer rate distribution along the heat exchanger surface are shown in diagrams. The varying of mass flow rate is conducted in two ways. In the first way, the input and output current temperatures are kept unchanged, while in the second way the heat exchanger area is kept unchanged. All operating points of parallel flow heat exchanger are marked in dimensionless diagram. Effect of the change of stream velocity on the heat transfer coefficient is shown in table, using, in the analyzed cases, the calculated values.

2. The mathematical model

The parallel flow „tube in tube“ heat exchanger (PFHE) is schematically shown in Figure 1. The colder stream is the weaker stream, with inlet temperature ϑ_1', which flows through the inner tube, while the warmer stream as stronger stream, with inlet temperature ϑ_2' flows parallel through the annular cross-section and in the same direction. Because of the temperature difference of streams, heat flow rate passes through the dividing wall from the warmer to the colder fluid. Thereby warmer stream is cooling, and colder stream is heating. It is clear that temperatures along the heat exchanger surface will change, and also the temperature difference and the heat flow rate. Maximum temperature difference is in the inlet, while the minimum is in the outlet of heat exchanger.

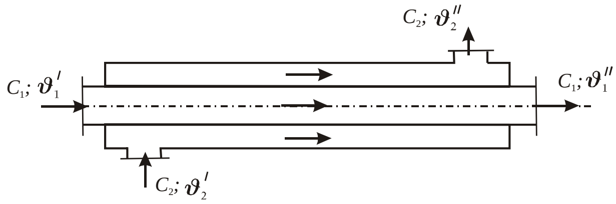

Figure 1. Schematic representation of the parallel flow heat exchanger

The expression for the heat flow rate on differential heat exchanger surface, for the parallel flow heat exchanger has the form:

$$\delta\Phi = k(\vartheta_1 - \vartheta_2)dA \qquad (1)$$

Total heat flow rate is obtained by integrating equation (1) along the entire heat exchanger area, from A = 0 to $A = A_0$:

$$\Phi = \int_{A=0}^{A=A_0} k\,(\vartheta_1 - \vartheta_2)dA \qquad (2)$$

The problem of solving of this integral consists of defining the temperature difference of streams, i.e. finding the functions $\vartheta_1=\vartheta_1(A)$ and $\vartheta_2=\vartheta_2(A)$, and also their difference $\Delta\vartheta(A)=\vartheta_1(A)-\vartheta_2(A)$. In determining the temperature distribution of streams along heat exchanger surface, the first step is to set the first law of thermodynamics for both streams. Substituting equations $\delta\Phi=C_1 d\vartheta_1$ and $\delta\Phi=-C_2 d\vartheta_2$ in equation (1) the differential equations for streams in the parallel flow heat exchanger are:

$$k(\vartheta_2 - \vartheta_1)dA = C_1 d\vartheta_1 \qquad (3)$$

$$k(\vartheta_2 - \vartheta_1)dA = -C_2 d\vartheta_2 \qquad (4)$$

Differential equations (3) and (4) represent a system of two ordinary homogeneous differential equations with constant coefficients, where the values of k, C_1 and C_2 are taken constant. For the parallel flow heat exchanger, boundary conditions are prescribed as follows:

for A=0; $\rightarrow \vartheta_1 = \vartheta_1';\ \vartheta_2 = \vartheta_2'$ (5)

Particular solution for the temperature distribution of the first and second stream along the parallel flow heat exchanger surface follows:

$$\vartheta_1 = \vartheta_1(A) = \frac{\pi_3\vartheta_1' + \vartheta_2'}{1+\pi_3} + \frac{\vartheta_1' - \vartheta_2'}{1+\pi_3}\exp\left(-k\frac{C_1+C_2}{C_1C_2}A\right) \quad (6)$$

$$\vartheta_2 = \vartheta_2(A) = \frac{\pi_3\vartheta_1' + \vartheta_2'}{1+\pi_3} - \pi_3\frac{\vartheta_1' - \vartheta_2'}{1+\pi_3}\exp\left(-k\frac{C_1+C_2}{C_1C_2}A\right) \quad (7)$$

In this model, the heat transfer rate with the environment is neglected, so the formula for calculating the heat flow rate expressed by the inlet and outlet temperatures of the streams follows:

$$\Phi(A) = C_1\left(\vartheta_1' - \vartheta_1(A)\right) = C_2(\vartheta_2(A) - \vartheta_2') \quad (8)$$

From the following differential equations for the counter flow heat exchanger (CFHE)

$$k(\vartheta_1 - \vartheta_2)dA = C_1 d\vartheta_1 \quad (9)$$

$$k(\vartheta_1 - \vartheta_2)dA = C_2 d\vartheta_2 \quad (10)$$

and prescribed boundary conditions:

$$A = 0; \rightarrow \vartheta_2 = \vartheta_2';$$

$$A = A_0; \rightarrow \vartheta_1 = \vartheta_1'; \quad (11)$$

the particular solution for the temperature distribution of the first and second stream along the counter flow heat exchanger surface can be written in the following form:

$$\vartheta_1 = \vartheta_1(A) = \frac{\vartheta_2' \exp(-(\pi_3 - 1)\pi_2) - \pi_3\vartheta_1'}{(\exp(-(\pi_3 - 1)\pi_2) - \pi_3} + \frac{\vartheta_1' - \vartheta_2'}{\exp(-(\pi_3 - 1)\pi_2) - \pi_3}\exp\left(-k\frac{C_1 - C_2}{C_1C_2}A\right) \quad (12)$$

$$\vartheta_2 = \vartheta_2(A) = \frac{\vartheta_2' \exp(-(\pi_3 - 1)\pi_2) - \pi_3\vartheta_1'}{(\exp(-(\pi_3 - 1)\pi_2) - \pi_3} + \pi_3\frac{\vartheta_1' - \vartheta_2'}{\exp(-(\pi_3 - 1)\pi_2) - \pi_3}\exp\left(-k\frac{C_1 - C_2}{C_1C_2}A\right) \quad (13)$$

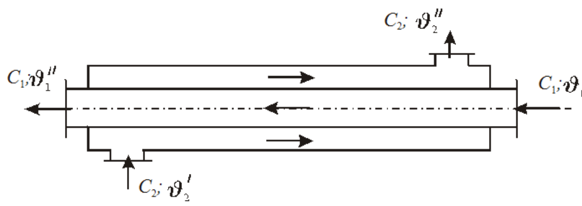

Figure 2. Schematic representation of the counter flow heat exchanger

3. Dimensioning of the heat exchanger

The first step in this analysis is to determine dimensions of the heat exchangers for the known temperatures of the streams. The colder stream (water) temperature at the inlet of the heat exchanger is ϑ_1'=18 °C and at the outlet is ϑ_1''=37 °C. The first stream is heating with the warmer stream (water), which is cooling from ϑ_2'=60 °C to ϑ_2''=50,5 °C. The mass flow rate of the colder stream, which flows through the inner tube of heat exchanger, has a value q_{m1}=0,06 kg/s, and the mass flow rate of the warmer stream, which flows through the annular section between the outer and inner tubes is q_{m2}=0,12 kg/s. The material of the heat exchanger is copper, with thermal conductivity of λ_{Cu}=386 W/(m·K). The area of the heat exchanger is calculated from the formula expressed using dimensionless pi parameters (π_1, π_2, π_3). Parameter π_1 is determined from the given temperatures of the streams, and parameter π_3 is obtained as the ratio of the heat capacities of the streams.

$$\pi_1 = \frac{\vartheta_1' - \vartheta_1''}{\vartheta_1' - \vartheta_2'} = \frac{18-37}{18-60} = 0{,}4524 \quad (14)$$

$$\pi_3 = \frac{C_1}{C_2} = \frac{q_{m1}c_w}{q_{m2}c_w} = \frac{0{,}06}{0{,}12} = 0{,}5 \quad (15)$$

Formula for determining π_2, [1], and its value for the considered parallel flow heat exchanger follows

$$\pi_{2i} = -\frac{ln[1 - \pi_{1i}(1+\pi_3)]}{1+\pi_3} = 0{,}7567 \quad (16)$$

For the counter flow heat exchangers, it is

$$\pi_{2p} = \frac{ln[(\pi_{1p} - 1)/(\pi_{1p}\pi_3 - 1)]}{\pi_3 - 1} = 0.69 \quad (17)$$

The area of the heat exchanger is calculated from the parameter π_2:

$$A_{0i} = \frac{\pi_{2i}C_1}{k} \quad (18)$$

Before this calculation, the overall heat transfer coefficient k should be determined. The procedure for the calculation of the overall heat transfer coefficient is given in [2]. It has the same value for the parallel and the counter flow heat exchanger and it is k=1601,42 Wm^{-2}K^{-1}.

For the parallel flow heat exchanger, the calculated total area of the heat exchanger is A_{0i} =0.1187 m^2 and for the counter flow heat exchanger it is A_{0p} =0.1082 m^2.

For the selected diameters of the heat exchanger (inner tube: d_{in}=13 mm, d_{out}=15 mm, outer tube: D_{in}=20 mm, D_{out}=22 mm), the length of the PFHE is L_i=2.52 m and of the CFHE L_p=2,3 m.

The temperature distribution along the parallel flow heat exchanger surface is shown in Figure 3 and presents the expressions (6) and (7). It can be seen the typical temperature distributions of the parallel flow heat exchanger: the larger slopes of the curves in the inlet then in the outlet of the heat exchanger.

The temperature distribution along the counter flow heat exchanger surface is shown in Figure 4 and presents the expressions (12) and (13). Greater temperature difference is in the outlet of the heat exchanger, so for A=A_0 the curves have the largest slopes.

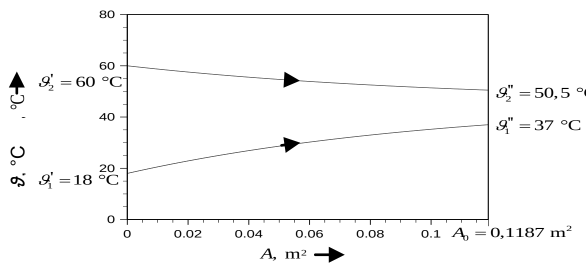

Figure 3. The temperature distributions of the streams along the surface of PFHE

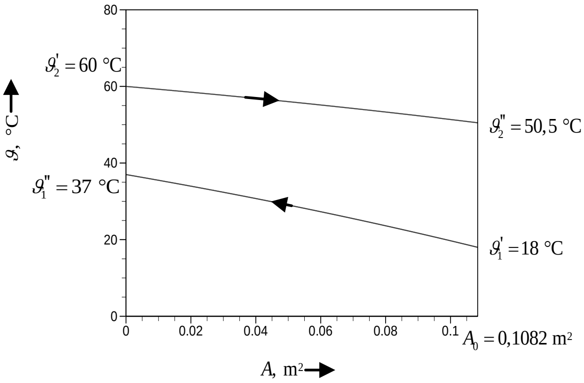

Figure 4. The temperature distributions of the streams along the surface of CFHE

The total heat flow rate along the heat exchanger surface for PFHE is shown in Figure 5 and for CFHE in Figure 6.

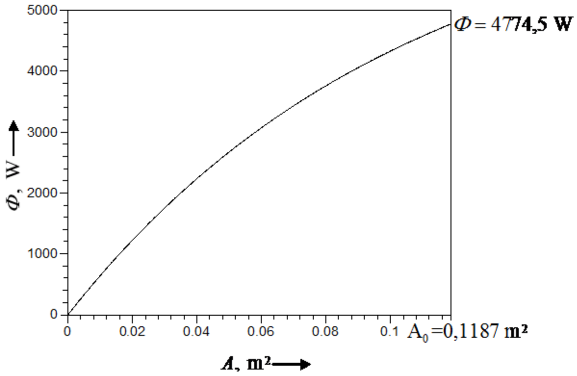

Figure 5. Total heat flow rate along the parallel flow heat exchanger surface

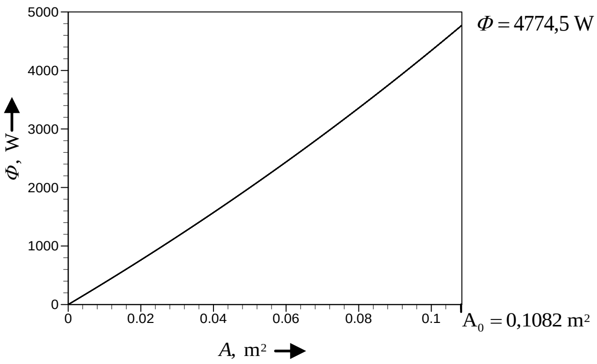

Figure 6. Total heat flow rate along the counter flow heat exchanger surface

The total exchanged heat transfer rate is equal for the both heat exchangers (Φ=4774,5 W), but CFHE has the smaller heat exchanger area.

It can be seen the difference in the shape of curves that present the total heat flow rate. With the increasing of heat exchanger area, the slope of the curve is decreasing for the PFHE and is increasing for the CFHE.

The computer program in FORTAN is used for the calculations of the temperature distributions and the total heat flow rates.

4. Analysis of heat exchangers by the variation of the mass flow rate

The heat exchanger is analyzed at the same values of input and output temperatures. The three cases for parallel flow and the three cases for counter flow heat exchanger are considered and for the PFHE they are presented using the working points (in the diagram which is shown in Figure 7). In all cases the input and output stream temperatures are equal, so the dimensionless parameter π_1 is equal in all cases, which is shown (in Figure 7) by the horizontal line which connects the three working points. Determination of the values of the area of heat exchanger for all cases is skipped in this work (it is given in [2]); only summarized results are given in Table 1. Internal and external diameters of tubes are specified in the previous chapter. The heat transfer coefficient is the very important quantity for the heat transfer and it depends on the properties of the fluid and the velocity of the stream. It is necessary to know its value to determine the overall heat transfer coefficient. Velocity of the first stream is equal in all three cases, while the velocity of second stream is changing with the change of the mass flow rate.

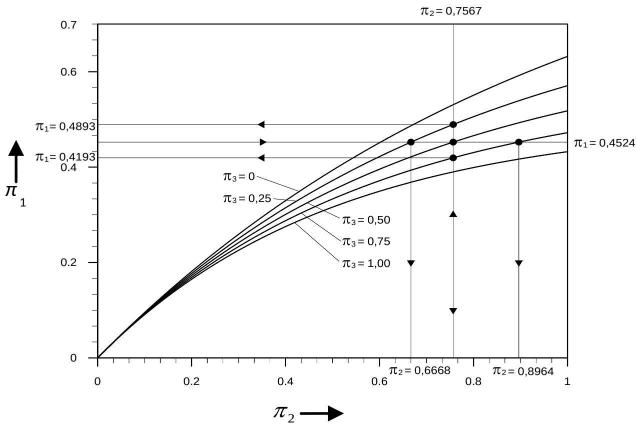

Figure 7. Operating points of the PFHE

The heat exchanger efficiency is also analyzed. The efficiency of the heat exchanger is the ratio of actually achieved temperature difference of the weaker stream and the difference of inlet temperatures of the streams. For both types of heat exchanger it is equal to the parameter π_1. Analysis of the efficiency of parallel flow heat exchanger is conducted on the heat exchanger with the value of the area A_0 = 0.1187 m^2 and the length L = 2.52 m. This heat exchanger is presented with the working point in the diagram in Figure 6 with the values π_2=0.7567, π_1=0.4524,

π_3=0.5. For the given value π_2=0.7567, the value of parameters π_3 varies, the values of parameter π_1 are calculated, and the corresponding values of the heat exchanger efficiency are obtained and written in Table 1 for PFHE. The same procedure is performed for CFHE.

Table 1. All relevant quantities for PFHE and CFHE

		Parallel flow heat exchanger					Counter flow heat exchanger				
		Point 1	Point 2	Point 3	Point 4	Point 5	Point 1	Point 2	Point 3	Point 4	Point 5
q_{m1}	kg/s	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06
q_{m2}	kg/s	0,24	0,12	0,08	0,24	0,08	0,24	0,12	0,08	0,24	0,08
Para-meters	π_1	0,4524	0,4524	0,4524	0,4893	0,4193	0,4524	0,4524	0,4524	0,4747	0,4296
	π_2	0,6668	0,7567	0,8964	0,7567	0,7567	0,6429	0,69	0,5710	0,69	0,69
	π_3	0,25	0,5	0,75	0,25	0,75	0,25	0,5	0,75	0,25	0,75
w_1	m/s	0,454	0,454	0,454	0,454	0,454	0,4537	0,4537	0,4537	0,4537	0,4537
w_2	m/s	1,774	0,886	0,596	1,774	0,596	1,772	0,886	0,596	1,774	0,596
α_u	$Wm^{-2}K^{-1}$	2445,1	2445,1	2445,1	2245,7	2076,6	24451	2445,1	2445,1	2230,4	2193,7
α_v	$Wm^{-2}K^{-1}$	11776,4	6677,51	4787,7	12040,6	4715,52	11776,4	6677,51	4787,7	12054,7	4667,1
k	$Wm^{-2}K^{-1}$	1787	1601,4	1462,9	1674,7	1279,9	1787	1601,4	1463	1658,2	1345,5
A_0	m^2	0,1064	0,1187	0,1539	0,1345	0,1759	0,0904	0,1082	0,1290	0,1045	0,1288
L	m	2,26	2,52	3,27	2,85	3,73	1,92	2,3	2,74	2,22	2,73
ϑ_1'	°C	18	18	18	18	18	18	18	18	18	18
ϑ_1''	°C	60	60	60	60	60	60	60	60	60	60
ϑ_2'	°C	37	37	37	38,55	35,61	37	37	37	37,94	36,04
ϑ_2''	°C	50,5	50,5	50,5	54,86	46,79	50,5	50,5	50,5	55	46,47

It can be seen from Table 1 that heat transfer coefficient depends on the stream temperatures and stream velocities. For the same boundary conditions, overall heat transfer coefficient is equal for the PFHE and CFHE because, it doesn't depend on the stream directions. The stream velocity has the important effect on the overall heat transfer coefficient. Increasing velocity causes an increase of the heat transfer coefficient and thus to increase the overall heat transfer coefficient.

This increase is not uniform. Hence, the two-fold increase of the velocity of the stronger stream (from 0.89 m/s to 1.78 m/s) led to an increase in overall heat transfer coefficient of 10%, while the increase of velocity from 0.6 m/s to 0.89 m/s (32.6%) resulted in an increase of the overall heat transfer coefficient of 8.6%.

This can be explained by the effect of the heat transfer coefficient in the inner tube and the thermal resistance through the tube wall, which remained unchanged.

For the same boundary conditions and for the same value of exchanged heat transfer rate, the required heat exchanger area of PFHE is 9.6% higher than the area of CFHE (in the case π_3=0,5). This percentage may be even higher; in the case of π_3=0.75 it was 16.2%, while in the case of π_3 = 0.25 the required area of the PFHE is 14.1% higher than the area of CFHE.

From the above it can be concluded that the of counter flow heat exchanger type is more economical that the parallel flow heat exchanger type, which is to be expected.

If the mass flow rate of the stronger stream through the PFHE is doubled, with nearly the same level of heat exchanger efficiency, it is needed to increase the heat exchanger area for 10% until for the counter flow heat exchanger this increase should be 16.5%.

Analysis of the heat exchanger, at the same dimensionless parameter of the heat exchanger area (same π_2) showed that the counterflow heat exchanger has a higher level of efficiency than the parallel flow heat exchanger. So, for example, for π_2=0.75 efficiency of the counter flow heat exchanger is 2.4% higher than the efficiency of the parallel flow heat exchanger.

5. Conclusion

In the work differential equations for parallel and counter flow heat exchanger with corresponding boundary conditions are given and particular solutions are calculated for the known inlet and outlet stream temperatures. The heat exchanger is dimensioned and the values of heat transfer coefficient are presented. The analysis carried out by the varying mass flow rate quantitatively showed the better efficiency of the counter flow heat exchanger.

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MELTING OF PARAFFIN IN RECTANGULAR CAVITY WITH THE INFLUENCE OF NATURAL CONVECTION

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Abstract
The unsteady two-dimensional melting of paraffin in a rectangular cavity with isothermal vertical walls is analyzed numerically using FORTRAN computer code. The results of simulation, a position of melting front and time evaluation of temperature are compared with experimental results.

Keywords:
Melting of paraffin, Finite Volume Method, Rectangular cavity

1. Introduction

Thermal energy can be stored in phase change material (PCM) as a heat of fusion (solid–liquid transition). PCMs allow large amounts of energy to be stored in a relatively small volume, resulting in some of the lowest storage media costs of any storage concepts. Materials to be used for phase change thermal energy storage must have a large latent heat and high thermal conductivity. They should have melting/freezing temperature in the practical range of application. Materials that melt between 15 °C and 30 °C are used to store the cold from air conditioning and free cooling and to maintain the room temperature [1,2].
Relevant PCMs for usage in rooms are paraffin, salt hydrates and their mixtures. The most common method for obtaining paraffin is to extract it during the refining process of crude oil. It is noteworthy for its chemical stability and a high specific heat capacity. Phase instability and supercooling effects, with a solidification temperature below melting point are quite unusual. Flammability and low heat conductivity cause a reduction in paraffin's effectiveness. There are several options where and how PCMs can be used to meet the cooling requirements. They can be integrated into the building's envelope (i.e., walls, roofs, and floors) increasing thermal mass. It is also possible to install them into HVAC system as a cold storage tank or to use them in solar cooling systems as a heat/cold storage tank [3]. Rectangular tank with the geometrical simplicity has been extensively used in practical application. However, movements of the fluid and heat transfer processes in the tanks are greatly complicated due to space limitations and flow of fluid. They not only depend on properties of the fluid and the temperature difference between the hot surface and the cold surface, but also depend on the shape structure and size of space.

In this work a phase change process - melting of paraffin in rectangular cavity in the presence of natural convection is considered numerically. The presented method is able to handle situations met in latent heat storage systems. Details of the adopted numerical method are given in [4]. Computer code written in FORTRAN developed in the Faculty of Mechanical Engineering and Naval Architecture is used for numerical simulations. The numerical simulation of the process provides the time evolution of the temperature fields in both phases and of the shape and position of the melting front. The numerical results are compared to the measurements obtained on a experimentally set described in [5].

2. Mathematical model and numerical method

Unsteady two dimensional melting with natural convection is governed by the basic laws represented by the continuity, momentum and energy equations and by the following assumptions: the liquid phase is incompressible and the Boussinesq approximation is met, the flow is laminar, and viscous dissipation is neglected. The mathematical model takes the dimensionless form

$$\frac{\partial U}{\partial X}+\frac{\partial V}{\partial Y}=0 \tag{1}$$

$$\frac{\partial U}{\partial \tau}+U\frac{\partial U}{\partial X}+V\frac{\partial U}{\partial Y}=-\frac{\partial P'}{\partial X}+Pr\left(\frac{\partial^2 U}{\partial X^2}+\frac{\partial^2 U}{\partial Y^2}\right) \tag{2}$$

$$\begin{aligned}&\frac{\partial V}{\partial \tau}+U\frac{\partial V}{\partial X}+V\frac{\partial V}{\partial Y}=\\&=GrPr^2\left(\theta-\theta_0\right)-\frac{\partial P'}{\partial Y}+Pr\left(\frac{\partial^2 V}{\partial X^2}+\frac{\partial^2 V}{\partial Y^2}\right)\end{aligned} \tag{3}$$

$$\frac{\partial \theta}{\partial \tau}+\left(U\frac{\partial \theta}{\partial X}+V\frac{\partial \theta}{\partial Y}\right)=\left(\frac{\partial^2 \theta}{\partial X^2}+\frac{\partial^2 \theta}{\partial Y^2}\right)+\frac{1}{Ste}\cdot\frac{\partial f}{\partial \tau} \tag{4}$$

Boundary conditions for the considered problem include conditions at the solid impermeable isothermal or insulated wall and the boundary condition at the solid-liquid interface. At the impermeable wall the both velocity components are equal to zero. At the isothermal wall the boundary temperature is prescribed while at the insulated wall the normal derivative of temperature is equal to zero. At the solid-liquid interface the temperature is constant and equal to the melting temperature T_m. If the interface velocity is negligible, the Stefan condition at the interface follows from the energy equation, in the form

$$k_s \frac{\partial T}{\partial n}\bigg|_s - k_l \frac{\partial T}{\partial n}\bigg|_l = \rho_s h_L \frac{\partial n}{\partial t} \tag{5}$$

where the indices l and s refer to the liquid and solid phase, respectively, and n is the coordinate normal to the phase boundary.It is obvious that are three dimensionless parameters to specify phase change problem; Rayleigh number, Prandtl number and Stefan number.In order to solve the equations of mathematical model, the finite volume method using fixed rectangular grid has been adopted. The governing equations are discretised using the Exponential differencing scheme for the spatial derivatives and the fully implicit scheme for the time integration. For the pressure –velocity coupling the SIMPLER algorithm is used. Computer code in FORTRAN was used for numerical simulations of paraffin melting.Vertical cross section of the rectangular cavity of dimensions W and H containing paraffin is shown in 1. Boundary conditions are included in Figure 1: north and south boundary are adiabatic and east and west are isothermal. In the beginning, the cavity is filled with solid at initial temperature T_i which is equal or less than melting temperature, ($T_i \le T_m$). In the moment t=0, west, vertical wall is heated at the temperature greater than the melting temperature $T_W > T_m$, and east wall is maintained on the temperature T_E. The position of the interface at the moment t>0 is shown in Figure 1.

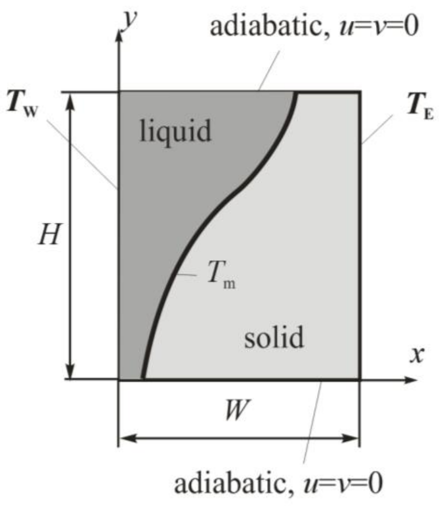

Figure 1. Schematic view of the melting process

In Table 1 the thermophysical properties of paraffin (99.9% pure) are reported and also other relevant data for the simulation.

Table 1.Values of the dimensionless parameters, the thermophysical properties and temperature differences in the melting process

Melting of paraffin	
Ra	$8.46 \cdot 10^{8}$
Gr	$1.6226 \cdot 10^{7}$
Pr	52.14
Ste	0.0691
Sb	2.40
λ_s, W/(m·K)	0.39
λ_l, W/(m·K)	0.157
c_s, J/(kg·K)	1900
c_l, J/(kg·K)	2200
ρ_s,kg/m^3	814
ρ_l,kg/m^3	754
a_s, m^2/s	$2.52 \cdot 10^{-7}$
a_l, m^2/s	$9.4 \cdot 10^{-8}$
ν_l, m^2/s	$5.005 \cdot 10^{-6}$
h_L J/kg	$2.41 \cdot 10^{5}$
T_m, °C	28.05
ΔT_s, °C	18.2
ΔT_l, °C	7.6
β, K^{-1}	$9.4 \cdot 10^{-4}$
H, m	0.177
W, m	0.069
B, m	1

Rayleigh number: $Ra = \frac{g\beta \Delta T_l H^3}{\nu_l a_l}$ (6)

Prandtl number: $Pr = \frac{\nu_l}{a_l}$ (7)

Stefan number: $Ste = \frac{c_l \Delta T_l}{h_L}$ (8)

Subcooling parameter: $Sb = \frac{\Delta T_s}{\Delta T_l}$ (9)

Dimensionless time:

$$\tau = Fo \cdot Ste = a_l \cdot t \cdot Ste / H^2 \tag{10}$$

Dimensionless temperatures:

$$\theta_l = \frac{T - T_m}{\Delta T_l} \qquad \theta_s = \frac{T - T_m}{\Delta T_s} \tag{11}$$

where:

$$\Delta T_l = T_W - T_m, \qquad \Delta T_s = T_m - T_E \tag{12}$$

3. Result and discussion

The experimental cell [5], shown in Figure 2, containing the paraffin is rectangular parallelepiped of height H=0.197 m and width W=0.0688 m. The third dimension D= 0.6 m, is large compared to W and H, the edge effects are thus negligible and heat transfer expected to be two-dimensional. The two large vertical walls consist of metal heat exchangers through which water is circulated. The water flow path in each exchanger has been machined in a brass plate (hot wall) and in an aluminium plate (cold wall) in order to get as uniform as possible a temperature distribution on those two exchangers. The heat exchanger has been calculated for the temperature drop to be less than 0.2 °C. To get rid of short term temperature fluctuation due to regulation of thermostats driving the hot and cold exchangers, a 0.5 m^3 well insulated thermal bath in included in each loop. In the hot wall circulation loop high rates of energy extraction are expected. To avoid effects of thermal stratification and spatial in homogeneity in the hot thermal reservoir the water of the bath is not directly circulated in the hot wall, heat is extracted from the bath through a large mass heat exchanger constituting an independent inner loop in the heating system. The four end walls are made of 0.04 thick altu-glass plates and the hole cell is carefully insulated with 0.08 m thick styrofoam. The insulation of the vertical end walls is removable in order to allow the photographic observation of the melting front.

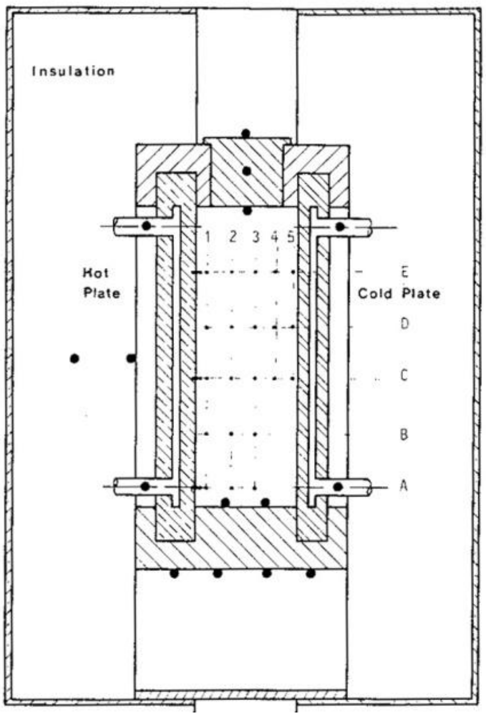

Figure 2. Vertical cross section of the experimental cell [5]

Sixty K-type thermocouples are used to register the evolution with time of the temperature of the system. 0.12 mm diameter thermocouples are located in the paraffin. On the sides of the end walls, in the insulation and in the circulation loops, 0.20 mm diameter thermocouples are used to check the stability of the temperatures and to estimate the heat losses of the cells.

In this paper, the uniform grid of 123x316 control volumes was used for simulation of the above described experimental situation. The bottom and top boundaries are adiabatic with the assumption of the zero tangential stress at the top boundary in the liquid phase (free surface). Total integration time was 10 hours and 45 minutes. In the computation, the variable time step was used: during the 1 hour and 45 minutes from the beginning of the process, time step was Δt=0.2 s, and later Δt=1 s.

Numerical results of the authors Benard, Gobin and Zanoli, [5] are also shown in this paper. The authors used the method with two domains (for the solid and liquid phase), and transformation of coordinates. Simulation was conducted on the grid 21x23 CV in liquid phase and 14x20 in solid phase. On the top boundary of the liquid phase the authors prescribed adiabatic boundary conditions, and on the top boundary of the solid phase they assumed constant melting temperature, what simulated the overflow of the liquid on the solid top surface.

The positions of the melting front at different times, obtaining by photographic recording (experimental results) and numerical simulations are represented in Figure 3. Solid black line denotes experimental results [5], black dashed line numerical results of the authors Benard, Gobin, Zanoli [5], and red solid line numerical results of the authors of this work. It is evident from Figure 3 that the agreement of the numerical simulation with the experimental results is good in the beginning of the melting process when the conduction is dominant Later, when the influence of natural convection is stronger, the agreement of the results is worse.
In moments 6h and 10h 45 min the discrepancies between results of the authors' numerical simulations and the experimental results are significant. Authors' simulations are conducted on the relatively fine grid, and according the experience in simulations of benchmarks phase change problems, the grid is sufficiently refined.

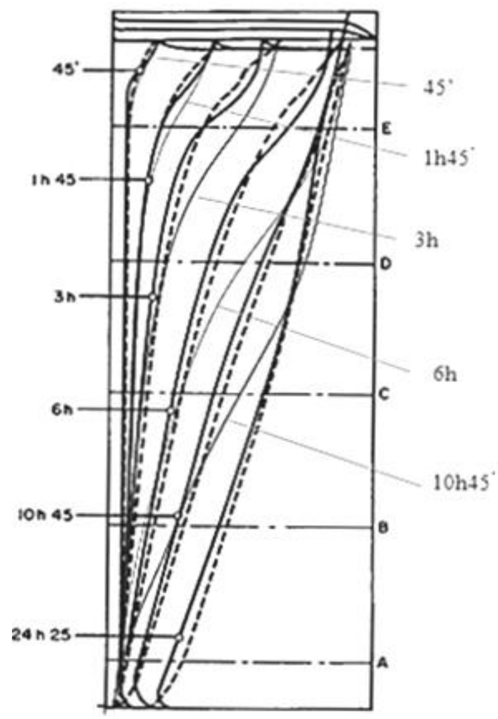

Figure 3. Time evolution of the melting front: experiment (solid black line), numerical simulation (dashed line) according [5] *and numerical simulation of the authors of this work (grey solid line)*

From Figure 3 it can be seen that curves which denote the shape and position of the melting front obtained experimentally, in the bottom part, at the point of contact with the south boundary are significantly curved. This indicates that in the experimental situation is not maintained adiabatic boundary as is assumed in the calculation, which could also be the cause of the disagreement results.

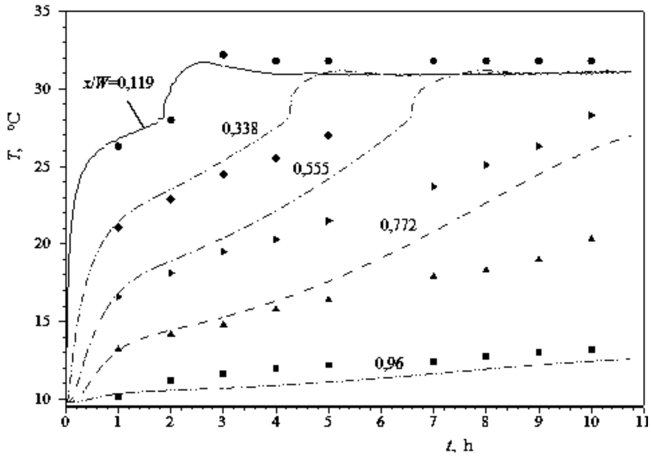

Figure 4. Time evolution of the temperature on the five locations (x/W= 0.119; 0.338, 0.555; 0.772 and 0.96) at the height y/H=0.662 – comparison of the results from the authors' simulation (solid lines) with the experimental results (symbols) according [5]

It can be seen again better agreement of the numerical and experimental results at the beginning of the melting process, and in the field of paraffin close to the vertical walls, while in the interior of the cavity the agreement is worse. Better insight in the melting problem would be obtained by the performing of the own experiment. To extend the numerical model with the enhancement of the heat transfer and to perform this experiment and the experiment of melting process with the enhanced heat transfer using fins are the goals of the future research.

4. Conclusion

Although PCMs may seem an attractive option there is still much to be explored and improved. One problem is the heat transfer on the air as well as on the PCM side. It can happen that the PCM will not solidify completely in the desired time, therefore an appropriate design of the heat exchangers and also mode of operation are essential. Another problem is also in the amount of material needed for thermal storage. Studies have shown that the range is somehow between 3 and 30 kg per m^2 [6] of floor plan area depending on the material, climate, cooling system, thermal load, etc. This means that the quantity of the material required for buildings would be enormous which is not considered really in favour of the PCM.
A lot of studies and research have to be done, which will eliminate current deficiencies and make these systems attractive from an economical and energetic point of view.

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APPLICATION OF A TRAVELING REST AT THREAD GRINDING

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Abstract

To increase the accuracy and productivity of thread grinding of precision lead screws for machine tools, attachments and tools it's suitable to apply a method for multipass longitudinal machining with a traveling rest and double sided support of the work piece, which technology and suitable equipment are represented in this article. The usual method for longitudinal grinding of parts with poor rigidity like piston rods, lead screws, drills, taps, broaches, etc. is characterized with application of one or several rests. They are mounted on the machine tool's table and are relatively still with respect to the work piece.

Keywords:
traveling rest, thread grinding, lead screw

1. Introduction

In general grinding of thread profiles of long lead screws for machine tools causes serious technological problems. Most often specialized machines are used and on their work tables several steady rests are fixed, figure1a [1]. Similar are the problems connected with longitudinal machining of piston rods and tools with low rigidity, which imposes additional support of the work pieces. To grind threaded surfaces, the abrasive tools are tilted digitally or positioned at required lead angle of the thread line, figure 1b [1].

Figure 1a. Grinding of long lead screws with steady rests

Figure 1b. Work zone of a grinding machine for machining of short threaded profiles

Figure 1. Thread grinding machines produced by Doimak [1]

The aim of this work is to present the possibility to apply the method for multipass longitudinal machining with traveling rest [2] when executing operations for external circular and thread grinding of components of lead screw type. In such cases is suitable to apply a rest with double support of the work piece [3]. In the publication is presented the possibility for rough and finish machining of threaded profiles of screws with poor rigidity at single positioning when using multioperational machines of S242 (CombiGrind h) type [4] produced by Studer and Schaudt and the machining center presented in [5, 6]. Additional accent is imposed on the opportunity for profile longitudinal grinding of shafts with poor stability and continuous support of the machined surface, which is provided by the two carriage option of the multifunction machining center [5, 6].

2. Method

The traveling rest presented in [3] is suitable for application at longitudinal machining and thread grinding. The unit supports on two sides the pliable screw in the same position in which it's encompassed by the "split" nut in general purpose lathes. The technological idea of the design presented in the next paragraph is a guarantee for high accuracy of diameter and pitch of the lead screw along its whole length, regardless of its pliability due to forces caused by machining or by its own weight. When using a traveling rest [3] for double sided support, the machined section is always coaxial with the bearing journals.

3. Results

The sequence of the suggested technological process for finish machining of lead screw type components is as follows: cylindrical grinding of the external surface of the work piece with a straight profile wheel, followed by a thread grinding with a traveling rest for double sided support. The machining can be executed at one or two positioning, depending on the equipment of the customers. To execute both operations at one setting is necessary to use single or double carriage machine with two tools. On figure 2 in two views is presented the first operation for external grinding of a screw with trapezoidal thread using a rest for double sided support.

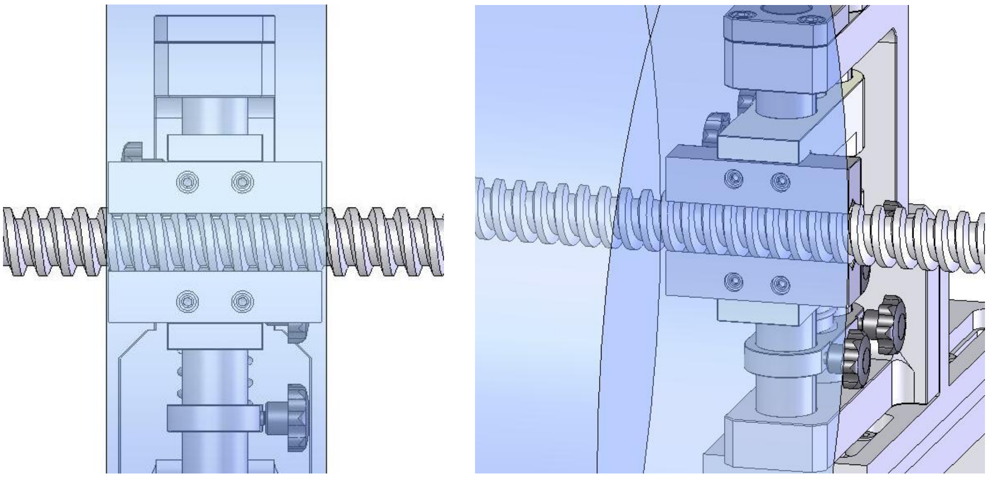


Figure 2. External grinding of a screw with trapezoidal thread with traveling rest for double sided support

On figure 3 is presented in two different views the second operation for thread grinding. The tool is tilted at the lead angel of the thread. The support of the component is done using the grinded surface. In this way is provided its coaxiality with the machined threaded profile.

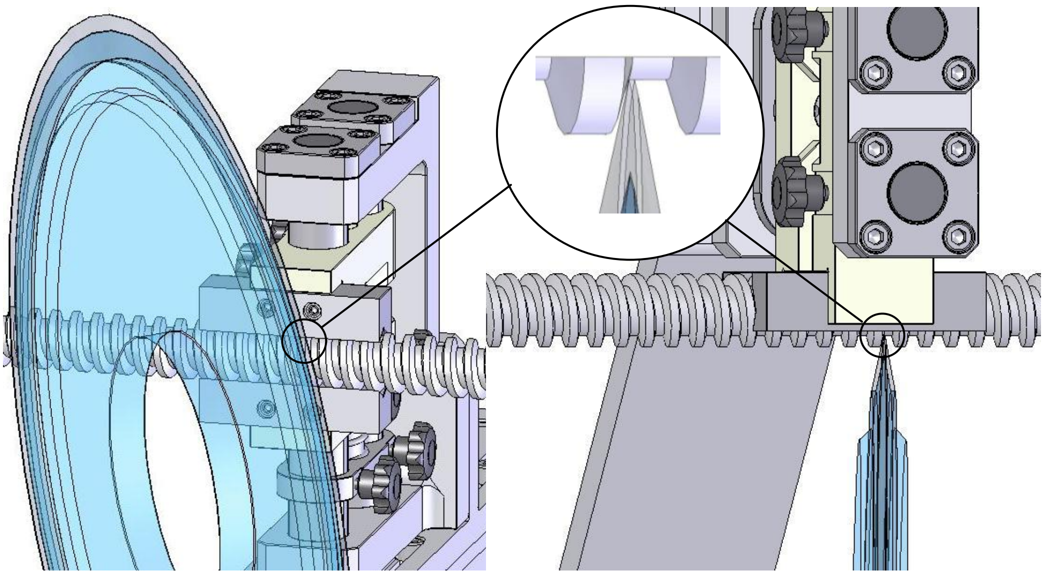


Figure 3. Thread grinding of a trapezoidal screw with a traveling rest for double sided support

The method can be applied for machining of all kinds of threaded profiles. For screws with substantial lengths is advisable to use CBN (Cubic Boron Nitride) wheels. The higher dimensional life of these tools will positively affect the accuracy and productivity of the thread grinding operation. On figure 4 is illustrated in two views machining of a threaded profile of a screw with metric thread with CBN wheel.

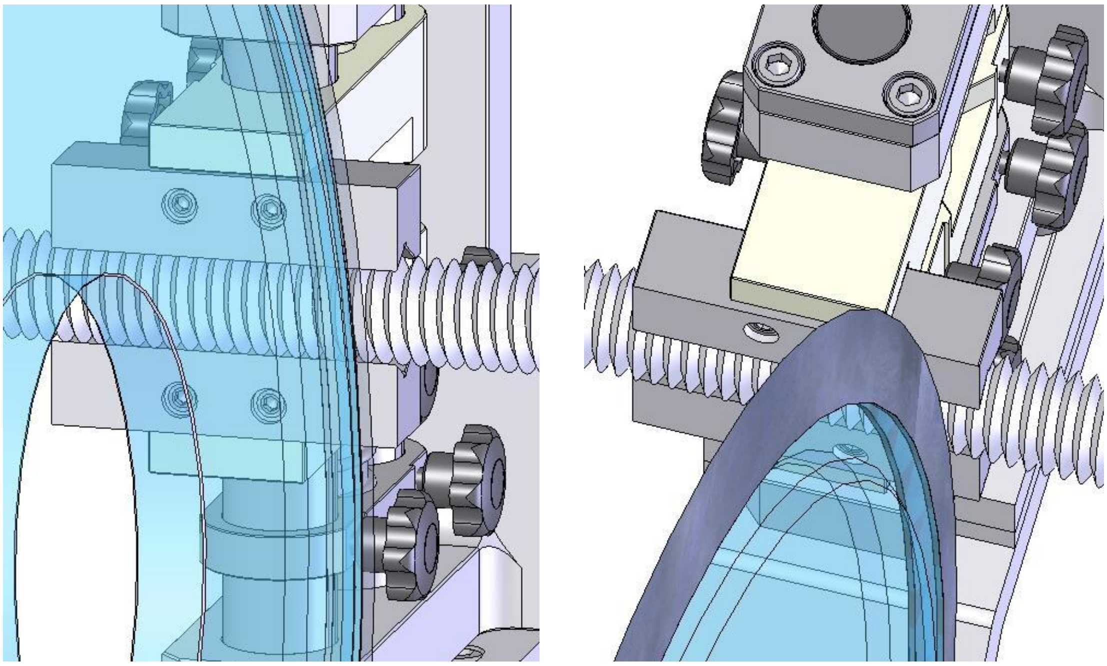
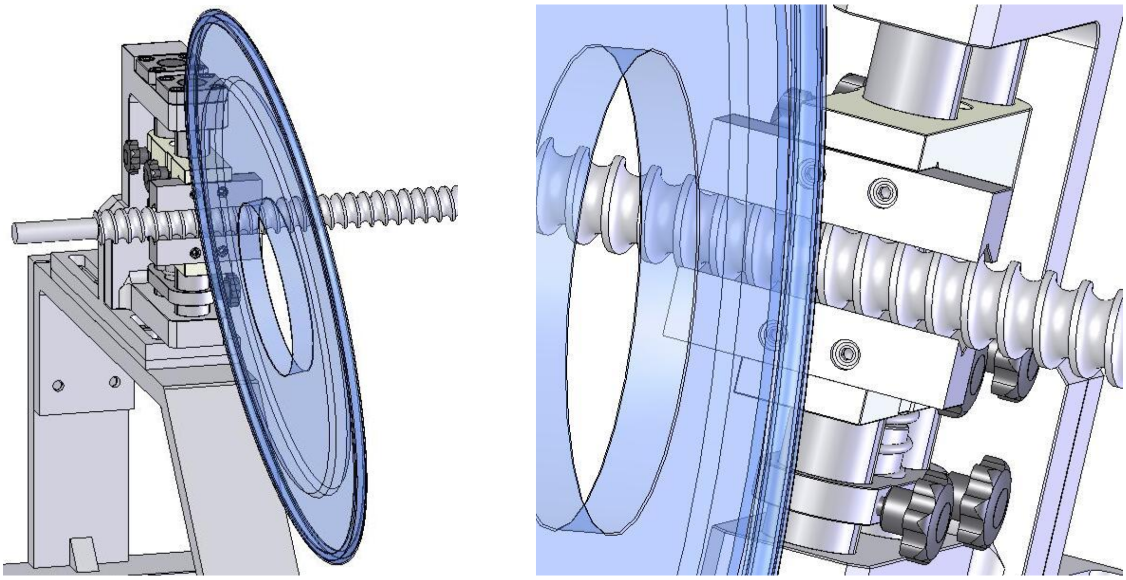
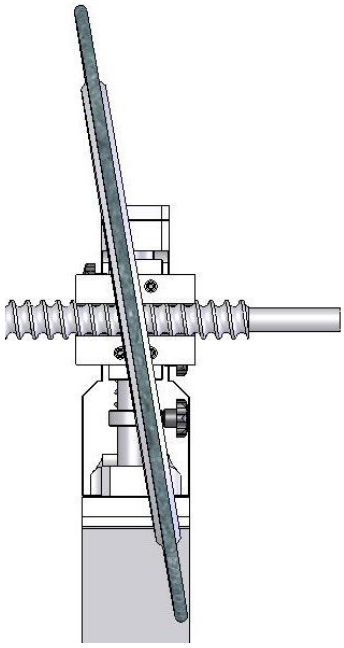


Figure 4. Longitudinal grinding of a metric thread at double sided support with a traveling rest

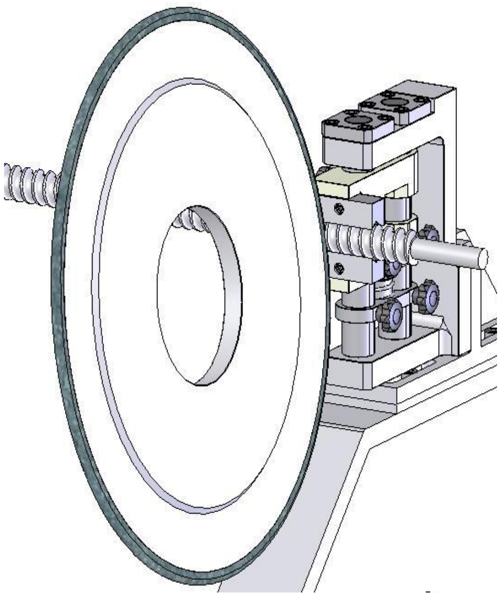
For CNC machine tools ball screws are widely used due to the high price of linear motors. The suggested method and device can be used for final machining of lead screws with different 'radii' profile of the thread. To clarify in full the positioning of the traveling rest, the tool and the work piece in the work zone of the thread grinder, the machining of a ball screw is given in four different views on figure 5.



a) *b)*



c)



d)

Figure 5. Grinding of a thread profile of a ball screw shaft with a CBN wheel with radial profile

4. Conclusion

The accuracy of positioning and the class of accuracy of a machine tool depend to a great extent on the limits of the technological possibilities to achieve precise shape and dimensions of the lead screws. In this publication is presented a new application of the method [2] for longitudinal grinding with a traveling rest [3] when machining thread profiles and cylindrical surfaces at one setting. The design and technological concept of the developed technological equipment, as well as the suggested and tested method for longitudinal grinding using traveling rest are guarantee for expected productive machining of accurate shape and dimensions of lead screws, which determine the final accuracy of machining. In the present work are given technologies and equipment for multioperational machine tools for machining different types of lead screws and profile components with poor rigidity. For all of them applications for inventions are submitted in the Patent office of Republic of Bulgaria.

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SELF-ORGANIZATION OF THE TRIBOSYSTEM "TOOL – PART" AFTER MAGNETIC-ULTRASONIC TREATMENT

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Abstract

The report confirms the previously raised hypothesis, that the increased resistance capacity of the ferromagnetic materials (cutting tools and parts), treated after the combined magnetic-ultrasonic technology arises by two processes, in two consecutive stages: is formation of a new surface (with improved structural and physico-chemical characteristics), in the treated materials; ii. change in the friction conditions, i.e. contact interactions, leading to structural adaptability, tribosystem self-organization (SO), resulting from the properties acquired during the first stage.

Keywords:
energy, self-organization

1. Introduction

According to the first principle of thermodynamics, the work of friction forces, A_{fr}, is principally converted into heat, Q, and a minute portion, ΔE, is applied to the materials in the tribosystem: $A_{fr} = Q + \Delta E$. Investigations on the energy balance of friction with precise methods allowed understanding that the conditions of friction influence not only the overall magnitude of the friction work, but also the relationship between the basic quantity of reserve energy and quantity of dissipated heat. This relationship, characterizing the tribosystem's work capacity, is determined by the normal load, P, the speed of relative displacement – v, and the vector of friction parameters – $\dot{C}$ (material properties, environment, temperature and so forth) [1]:

$$\Delta E/Q = \mathrm{f}\,(P, v, \dot{C}). \qquad (1)$$

The major component of the energy balance of friction is the reserve energy. The magnitude of ΔE is of critical importance during the generation of friction forces, determines the laws of formation of new structures, and the magnitude and nature of their subsequent destruction. Analysis of the laws of the energy balance, concomitant with the analysis of the structure and elementary content of the surfaces involved in friction, allows concluding, that all friction processes are actually the result of two basic phenomena – activation, i.e. increase in the free energy of the materials in the tribosystem, and passivation, the system's decrease in free energy.

The simplified representation of the friction force as function of the normal load appears to be invalid in the theoretical and empirical plan. It was shown that the friction force is actually not a function of the normal load, but rather the operator in the system, arising during a combination of normal load, sliding speed and vector of the friction parameter [2].

The problems associated with the SO process during friction relate to the domain of "highly parametrical" materials condition, i.e. high concentration of energy, high speed, high pressures, and anomalous physical conditions. The process is accompanied by the creation of structural and phase conditions, absent in the diagrams of systems in equilibrium. Under investigation of the process of secondary structure formation, carried out with electronic - transmitive and raster microscopy, roentgen – spectral and ojespectral analysis, electronography, roentgenography and radioactive indicators, it was found that the traditional mechanisms of volume plastic deformation under metal friction in the conditions of tribosystem SO are totally excluded. The kinetic phase transition leads to new mechanisms of plasticity, deformation and destruction [3]. It is essential to note, that the kinetic phase transition during SO regimen and formation of secondary structure is not random, but rather governed by minimal principles. All interactions during friction in SO regimen are localized in the thin surface layer. Major changes take place. It was found that the secondary structures are resistant and possess SO properties [4, 5]. A fundamental energy condition of the tribosystem's material SO is such dynamic equilibrium of the processes of the tribo activation and passivation, under which the active part of the activation energy, G_{Aef}, is equivalent to the reserve energy, ΔE, found in the limit energy values, necessary for the formation of the secondary structure,

$$G_{BC}: G_{Aef} = G_{BC}. \qquad (2)$$

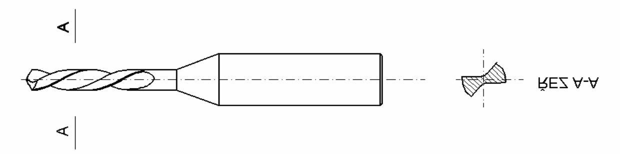
As a result from the violation of this condition, damage occurs. The relationship of G_{Aef} with the overall activation energy $G_{Aoverall}$ (the friction work – A_{fr}) is evaluated by the coefficient of reserve energy, K_r. The magnitude of K_r determines the SO diapason (SOD), and significantly influences the level of self-organization (LSO), under the optimal solution $K_r \rightarrow$ min. A major means of minimization of K_r is the application of methods for surface strengthening.

2. EXPERIMENTAL SETUP

To explore the influence of the combined magnetic-ultrasonic treatment of the dependent variables during drilling (axial force F_o and twisting moment M_B), investigations on the drilling process were carried out in the conditions of the TU - Prague, department of "Manufacturing technologies" [6]. The used drills, with ø = 2,3 mm, are made of high-speed steel – HSS 02 ČSN221121. A part of the drills was subjected to the combined magnetic-ultrasonic treatment in the tool "MUS – 1" (Fig.1), in the conditions of the TU - Sofia, using a treatment regimen, which has been previously associated with a significant increase in the durability of helical drills, namely H = 157 kA/m – intensity of the constant magnetic field; τ = 60s – treatment duration; and constant frequency of ultrasonic oscillations – F = 20 ± 1 kHz [5].

Steel M45 was used as billet material. The experiments conducted on a cutting machine model FV25 with CNC, using three cutting regimens (see table 1), with a constant depth of the drilled holes at L = 3d, and without the use of lubricating - cooling fluid. During the cutting process, the axial force and the twisting moment were measured with a four-component dynamometer model Kistler – 9272 connected to the processing software Dinoware. Five holes were always made with each drill, the processing software drawing the graphical dependencies for axial force and twisting moment, with a subsequent results averaging of the repeated experiments. The latter is done in order to minimize the influence of random factors on the final investigation results (Fig.2). Furthermore, optic microscope ZEISS equipped with a digital camera was used to document the wear at each 10th drill made, and the work of each drill was carried out until reaching a wear of one of its posterior surfaces VB_{max} = 0,5 mm, or until the drill was broken. Microsoft Excel 2007 platform was used to process and compute the results from the obtained graphical dependencies.

Figure 1.Equipment for magnetic-ultrasonic treatment-"MUS-1"



Drill - HSS 02 (ČSN221121); Workpiese-M45 stall; drilling holes L = 3d,

Cutting Mode: 1 - V_c = 25m/min (3460 tour); f=0,05mm/tour, 2 - V_c = 30m/min (4152 tour.); f=0,06mm/tour, 3 - V_c = 35m/min (5000 tour); f=0,07mm/tour

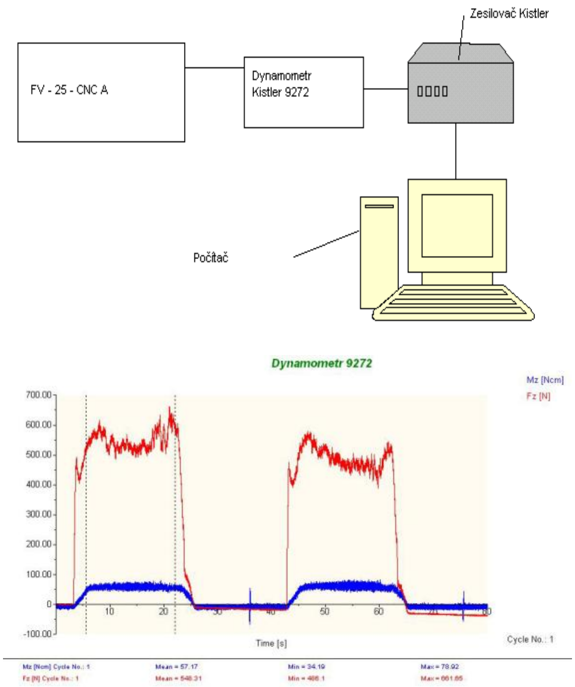


Figure 2. Experimental study

Table 1.Reported results for M_B [N.mm] and F_0 [N]

Number drilled holes	Ø 2.3 mm; V_c=25 m/min; f=0.05 mm/tour				V_c=30 m/min (4152 mm^{-1}); f=0.06mm/ tour				V_c=35 m/min (5000 min^{-1}); f=0.07 mm/ tour			
	Normal		Treated in MUS-1		Normal		Treated in MUS-1		Normal		Treated in MUS-1	
	M_B	F_0	M_B	F_0	M_B	F_0	M_B	F_0	M_B	F_0	M_B	F_0
1	23	312	12	193	24	219	15	200	23	321	13	149
5	34	284	18	220	50	179	13	192	33	269	12	165
10	29	363	15	211	31	277	12	186	62	265	14	173
15	40	303	14	216	38	211	12	194	46	389	16	239
20	32	345	14	209	32	207	16	203	42	324	12	181
25	35	303	13	165	36	255	19	222	–	–	12	160
30	27	275	14	200	–	–	–	–	–	–	11	192
35	46	365	13	189	–	–	–	–	–	–	12	191
40	22	314	13	185	–	–	–	–	–	–	12	231
45	37	298	11	207	–	–	–	–	–	–	13	170
50	76	310	15	200	–	–	–	–	–	–	12	219

Table 2.Reported results for the average-VB_k and maximum wear - VB_{max} on drills in μm

After number of holes	Wear of the drills			
	Normal		Treated in “MUS – 1”	
	VB_K	VBmax	VB_K	VBmax
1	20	48	25	24
5	80	157	64	65
10	109	216	65	95
15	130	351	68	117
20	160	450	70	141
25	168	480	75	166
30	177	495	79	186
35	210	504	85	194
40	225	506	90	223
45	245	509	95	237
50	263	515	110	265

3. RESULTS

Summarized in Table 1 are results for the twisting moment and axial force in the applied experimental cutting conditions during work with normal drills and for treatment drills. The recorded values for the average and maximal wear, VB_k and VB_{max} respectively, with the drilling of 50 holes with a work regimen of V_c = 25 m/min and f = 0,05 mm/tour, are exposed in Table 2 (see also Fig. 3 for graphical representation). The results show, that as a whole, the work with the preliminarily treated drills and for the three cutting regimens is conducted under significantly eased manufacturing conditions.

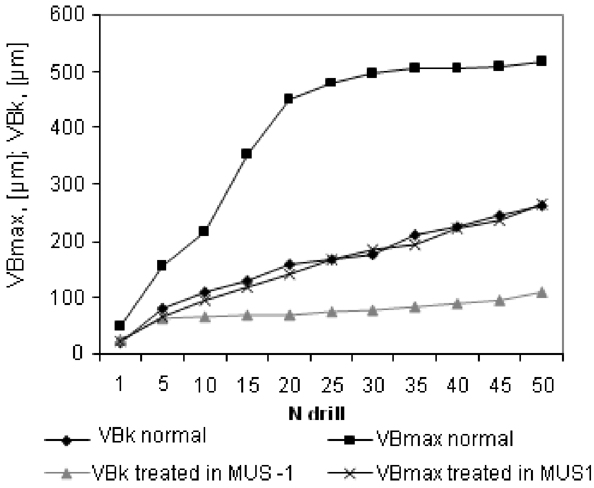


Figure 3. Wear curves for normal and subjected to magnetic-ultrasonic treatment drills.

4. CONCLUSIONS

The above results allow concluding that the work with tools subjected to magnetic-ultrasonic treatment, is accompanied with a change in the cutting conditions and in the “tool – part” contact interaction. The level of the obtained effect is directly dependent on the applied positive changes in the tool’s material density, and the occurred intensive relaxation processes of the accumulations of a larger number of atoms in the Kotrel atmospheres around dislocations [7].

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USING WATER JET IN ORTHOPAEDIC SURGERY

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Abstract
Paper refers to possibilities of the water jet technology utilization during (re)implantations of total endoprostheses of large joints aimed at minimizing the bone losses and thermo-mechanical damage to the bone tissue. Outlined are main problems and potential improvement by application of progressive technique water jet. Paper summarizes up-to-date research of the team. Reason of the research is to develop surgical technique, without heat and mechanical damage of large joints, with minimal traumatizing effects on the patient and a maximum yield for the society.

Keywords:
water jet, bone cement, bone, orthopedic, nursing

1. Introduction

Number of patients suffering from degenerative joint diseases (osteoarthritis) has been continually increasing and due to its seriousness, therapeutic complications and frequent patient/client (p/c) individualization the disease represents inherent and significant medical, economic and social issue [1, 11]. Number of revision interventions in cement and non-cement endoprostheses still increases [2]. To make a damaged total replacement to be extractable, it is necessary to break up interface between the bone and bone cement. To do this standard tools like drills or oscillation saws are used [3]. However, there are many disadvantages related to use of such instruments, whereas a risk of shattering, cracking and various other complications related to (re)implantation of total replacement increases. A long-term success of the implanted endoprosthesis does not lie only in the used surgical techniques yet in the method of cutting and machining of the bones, their properties and technological procedures, used bone cement, tribological properties of joints. Motivation of our research is global problems:

- A large number of patients and long time waiting for joint (re)implantation.
- Using special materials (titanium, bone cement – PMMA etc.),
- Number of complications due to the use of classical machine tools (cracks, thermal effect),
- Costly processes in terms of time, financial, material, human and social.

2. State of the art analysis

The first medical applications of the technology were published in the 80s when the water jet was used to cut the soft tissues [3]. In a large extent the water jet (WJ) is applied in all types of industry. In medicine practice the water is possible to be utilized, for instance, in cutting the organs; wound cleaning; liposuction; necrotic epidermis removal; extraction of metastasis and glioma; cutting the tissues, bones, tooth substance. Options of use of the water jet application and its advantages are described in [1,3,4,5,6]. Nowadays the studies researching the use of the water abrasive jet even in orthopaedics, for instance, in implantations and reimplantations of total replacement of the hip and knee joints are available [1,4]. The objective is to draw attention to the fact that in the future the WJ may replace so far exerted technological procedures to cut down on financial demands related to the surgical performance as well as to reduce the time of hospitalization and early return of a patient into the active life. According to the aforementioned the bone cutting by the conventional methods show a few problem areas with negative influence both upon the surgical performance itself and consequent patient's recovery after the surgery. In the first stage the mechanical properties of bone cement and disintegration process by water jet were studied.
Following figure 1 shows general overview of state of the art and potentialities connected with changing of water jet technology. It shows factors divided to groups by origin. From experience is apparent that most problems are connected with using of technology during stem (re)implantation.

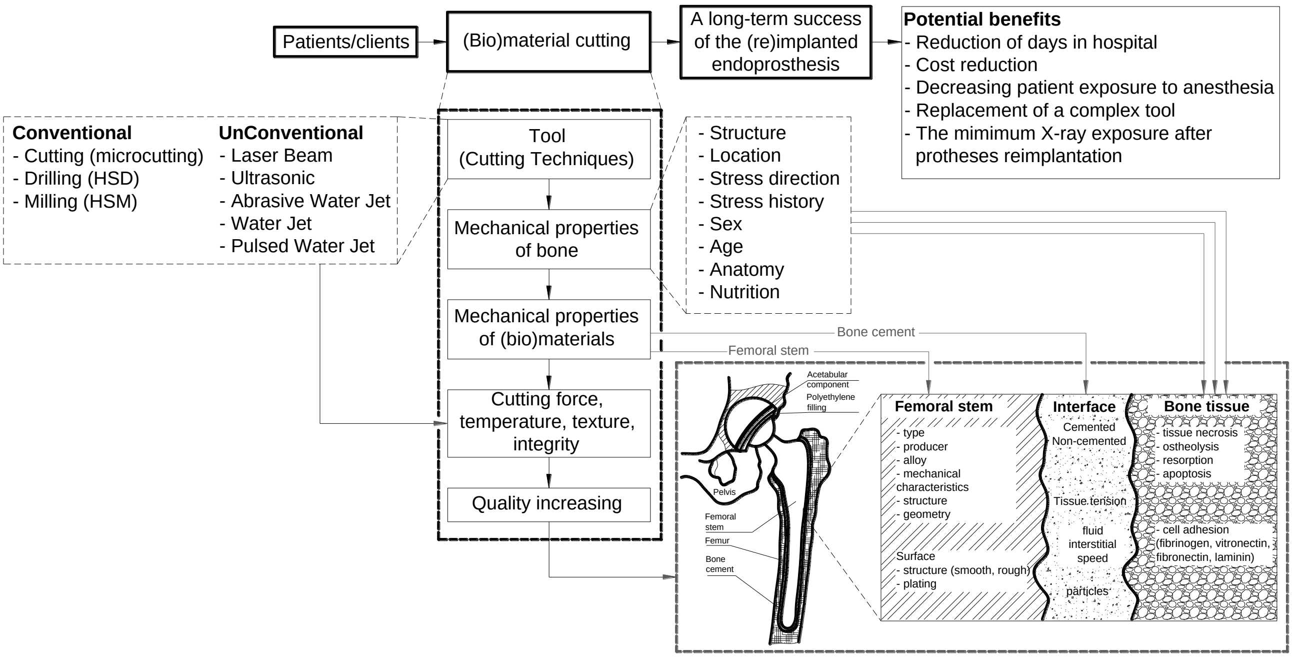

Figure 1. General graphic overview of state of the art and potentialities connected with changing of technology

3. Experimental Research Brief Review

In presented study following commercial bone cements were reviewed: Palacos R+G® (ZIMMER) which has a broad spectrum covering gram-positive and gram-negative bacteria, and Antibiotic Simplex with Tobramycin® (STRYKER, Howmedica Osteonics, Ireland) [7]. As a pre-mixed formulation, Palacos R+G provide a homogenous cement/antibiotic mixture and saves valuable OR time. Bone cements were prepared by manual mixing in strict compliance with manufacturer's instructions. Polymethylmethacrylate casting resin CH_2-$COOCH_3$-CCH_2 with drilled holes 3 mm deep (fig 2) has been used as a matrix material.

Figure 2. Samples of bone cement in casting resin

Diameters of holes are 2, 5 and 12,5 mm. During application of bone cements to casting resin retainer temperature was measured. Temperature was measured by infrared Thermometer UNI-T UT305C with single point laser with output < 1mV, wavelength 630 – 670 nm with period 1 minute. Fig. 3 show exothermic peak of each reviewed bone cements. It is apparent the influence of bone cements mass on temperature. The temperature behaviour during exothermic reaction of bone cement is different. The high values of temperatures were found during measuring samples created from Palacos R+G. In case of sample with diameter 12,5 mm and width 3-4 mm (Sample A) fixed in a casting resin was found that temperature exceed critical temperatures 47° [8] and 55°C [9] when osteonecrosis appear. Maximal measured temperature was 64°C.

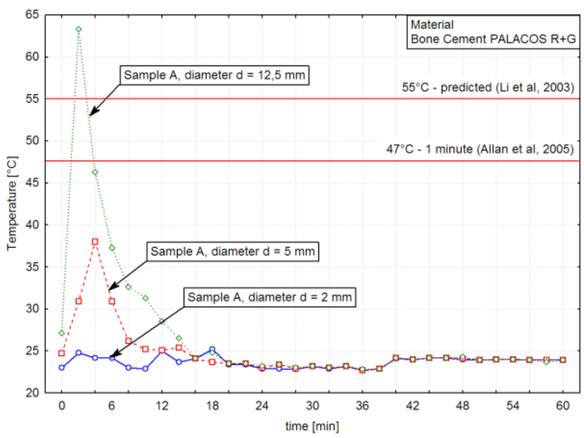

Figure 3. Temperature during polymerasion

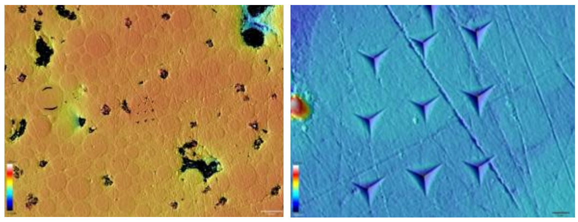

Figure 4. Surface of indents in bone cement

The samples sections for nanoindentation were metallographically polished down to roughness lower than 0.1 μm. All nanoindentation measurements were performed by nano-indentation tester TTX-NHT (by CSM Instruments, Switzerland). Berkovich pyramid diamond tip was used in simple monotonic mode with maximum loading of 10 mN. Loading and unloading rate was 20 mN/min, the hold time at the maximum was 10 s. The resulting load-penetration depth (P-h) curves were evaluated according to the analysis of Oliver and Pharr [12]. From the applied load and corresponding contact area, hardness values can be calculated very precisely.

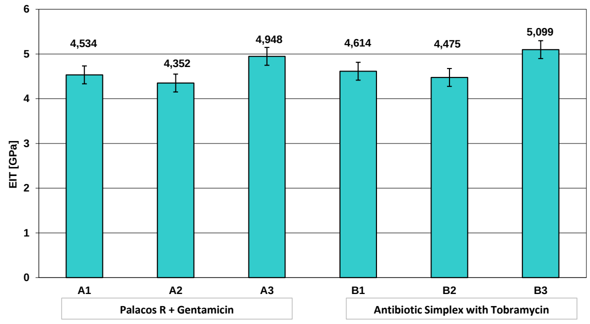

Figure 5. Bone cement Young modulus of elasticity

Those results (fig. 2,3,4,5) presents a comprehensive survey on the reported mechanical properties of bone cement. Variables that influence the mechanical properties, such as handling characteristics, strain rate, loading modes, additives, porosity, blood inclusion, in vivo environment, temperature, etc. have also been investigated. Future research areas important for fully characterizing the physical properties of PMMA are also suggested. Evaluated were nano-hardness of bone cements, porosity and exothermal behaviour expressed by temperature, compared with other studies [7,8,9], where critical temperatures causing osteo-necrosis are estimated. Existence of pores of various sizes has been found. Sizes depend on size of the sample. Results are valid for further investigation in order to rationalize (re)implantation of femoral stems in order to reduce thermal effect of bone cement. This way it is possible to preserve biological potential of bone during surgery. But as is mentioned in introduction number of revision interventions in cement and non-cement endoprostheses still increases. Effective surgical process depends on technology (fig. 1). Due to many benefits of water jet it is possible to use kinetic energy of waterjet for desctruction of bone cement – interface between femoral stem and cortical bone in case of reimplantation of femoral stems (fig. 1). With respect to modules of material elasticity in case of which modulus of elasticity of titanium endoprosthesis E_{Ti} = 200 GPa, modulus of elasticity of bone cement (PMMA) E_{bc} = 4,5-4,8 GPa (fig. 5), and modulus of elasticity of cortical bone tissue E_{bone} = 25 GPa there is an advantage resting in the fact that selective removal by fluid jet rests in removal of material of the lowest resistance rate. Considering low values of mechanical characteristics of bone cement the jet flow shall cold-create a crack between a cortical part of bone structure and the stem of the femoral component without mechanical damage or deformation to surrounding tissue during process of releasing of the stem of the component. This hypothesis was partially experimentally verrified by cutting the bone cement with water jet (Fig. 6 highlighted by red line) with pressure 200 MPa.

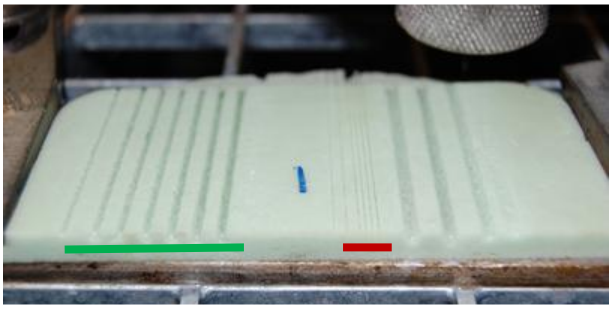

Figure 6. Cutting traces after disintegration of PMMA bone cement by pulsating and continual water jet

The intention of authors team is decreasing the technological level set up, in order to simplify the introduction of water jet technology to medical field. Thanks to effort of authors [10] it is possible to significantly increase efficiency of impact of continual fluid jet by its modulation at pressure level 8-20 MPa (Fig. 6 – green line). Generation of high-frequency pressure pulsations in systems for generation of high-speed water jets represents one of possibilities of technology efficiency increasing in medical applications for removal of surface layers, cleaning, and volume disintegrations of materials, for instance, bone cement in case of reimplantations of total replacements. The reason is represented by the fact that due to the pressure pulsations the water jet flows out from the orifice as continual jet of water, but due to pulsation it has a variable axial component of velocity.

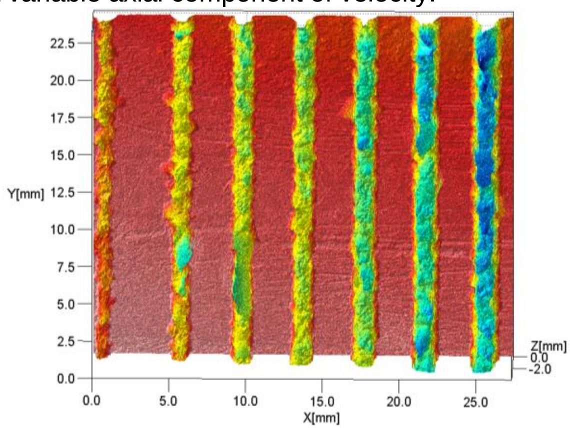

Figure 7. Record of cutting traces created by pulsating water jet

Other advantages represent small losses, quick and considerate technological process of cutting of even heavy porous bones. Considering its broad utilization, the technology appears to be used especially in case of reimplantations. Diameter of the water jet up to 2 mm (bone cement interface thickness is 3 mm [5]) means remarkable advantage while working in very small areas at interface of the prosthesis and bone tissue. The cutting process is basically cold, thus thermal effect will be avoided, and forces and reactions are relatively low. Accurate manipulation with an applicator is possible both in manual or robotic way. Given facts show possibility to remove prosthesis by the technique of cutting in quicker and more considerate manner. The following figure 8 shows the part of proposed workplace with application of automated on-line control of surgical resection of the hip joint using technology of water jet being solved within the thesis by Blichová.

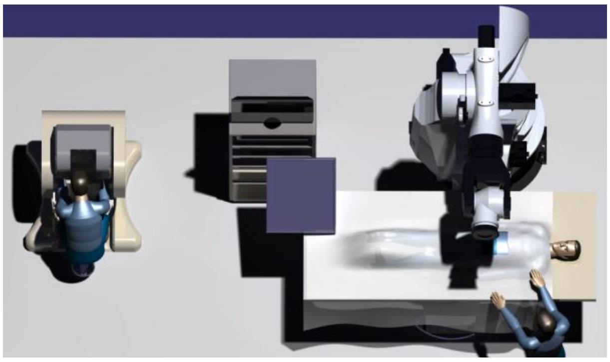

Figure 8. Pro-futuro workplace

9. Conclusions and Future Direction of Research

New technologies are still introduced even in orthopaedic practice with a promise of better care of patients, though often with limited pieces of information. Therefore hospitals, medical establishments, and surgeons face a need to evaluate relative advantages of new technologies to be able to consider possible benefits for patients. The aim is to decrease costs and potential undesirable clinical impacts connected with their use. This scientific research work is based upon possibility to apply the water jet cutting technology. It comprises outcomes of exploration and possibilities of utilization of the water jet cutting technology for purpose of responsible and profitable introduction of the technology in orthopedic practice. Innovation of the exerted surgical procedures with utilization of the water jet in medicine is a vision to the near future with solid foundation in fierce competitive market environment. Surgical operations using the water jet represent a potential instrument to enhance both surgical operations in favour of patient's life quality improvement and eventually general social and economic impact. Innovation of the exerted surgical procedures with utilization of the water jet in medicine is a vision to the near future with good foundation in a fierce competitive environment. In spite of considerable advance in the application of the water jet technology we are aware of the problems related to its application in clinical practice and thus we do believe that by the contribution a possible discussion focused on the field in question shall be initiated.

9. Acknowledgement

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COOLING OF WATER IN A CAVITY BY NATURAL CONVECTION –COMPARISON OF NUMERICAL RESULTS

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Abstract
The analysis of the temperature and velocity field during the transient two dimensional cooling of water by natural convection enclosed in rectangular cavity with wall temperature maintained at 0 °C is considered. This investigation is carried out in order to study the inversion of flow patterns caused by the maximum density of water at 4 °C. The comparison of the numerical results obtained using the software developed at the Faculty of Mechanical Engineering and Naval Architecture (FAMENA) and the results obtained using commercial software FLUENT is given. Discrepancy between the results practically doesn't exist that proves the accuracy of the developed model.

Keywords:
finite volume method, natural convection, water density anomaly

1. Introduction
Density is a physical property of matter which is not, for some fluids like water, liquid helium, bismuth and gallium, linear function of temperature; instead, density reaches its maximum at a specific temperature and decreases when deviating from this temperature. This phenomenon, known as density inversion, can significantly change the flow field and heat transport in a cavity. Natural convection in such liquids is of practical importance in phenomena such as oceanic movement, ice forming and melting, crystal growth, etc. Though the density inversion effect on natural convection has been studied extensively, the vast majority of these studies consider steady state flows in a cavity. Transient natural convection in the water subjected to density inversion was considered by Vasseur and Robillard [1], Braga and Viskanta [2], Tong and Coster [3], Nishimura el al [4]. This paper is motivated by the need of validation the results of computations obtained using the software developed at the Faculty of Mechanical Engineering and Naval Architecture with the results obtained using commercial software FLUENT.

2. Mathematical model and numerical solutions
Unsteady two-dimensional natural convection of water in a rectangular enclosure is governed by the basic laws represented by the continuity, momentum and energy equations and by the following assumptions: the flow is laminar and incompressible, the thermo physical properties are independent of temperature except for the density in the bouncy term, and the viscous dissipation is neglected. The mathematical model takes the following form:

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}=0 \qquad (1)$$

$$\rho_0\frac{\partial u}{\partial t}+\rho_0\left(u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}\right)=-\frac{\partial p}{\partial x}+\mu\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right) \qquad (2)$$

$$\rho_0\frac{\partial v}{\partial t}+\rho_0\left(u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}\right)=g\left(\rho_0-\rho\right)-\frac{\partial p}{\partial y}+\mu\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}\right) \qquad (3)$$

$$\rho_0 c\frac{\partial T}{\partial t}+\rho_0 c\left(u\frac{\partial T}{\partial x}+v\frac{\partial T}{\partial y}\right)=k\left(\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}\right) \qquad (4)$$

where *u* and *v* are the components of velocity field in the *x* and *y* directions, respectively; *T* is the temperature, *p* is the pressure, ρ is the temperature dependent density, ρ_0 is the referent density; *g* is the constant of gravity, *c* is the specific heat capacity, μ is the dynamic viscosity, *k* is the thermal diffusivity.

Boundary conditions for the considered problem include conditions at the solid, impermeable, isothermal walls. At the impermeable walls, both velocity components are equal to zero. At the isothermal walls, the boundary temperatures (T_W=0 °C) are prescribed. The model equations are solved numerically using the finite volume method [5] based on a fixed rectangular grid with a staggered grid arrangement for the velocity components. The exponential differencing scheme [6] is used for the spatial derivatives and the fully implicit scheme for the time integration. For the pressure-velocity coupling, the SIMPLER algorithm is used.
It is well known that the natural convection in water has a special feature because of the water anomaly. In the mathematical model the following

density-temperature relationship, which is valid in the temperature range 0-20 °C, is included:

$$\rho = \frac{\rho_0}{1 + k_1 T + k_2 T^2 + k_3 T^3 + k_4 T^4}$$

where:
ρ_0 = 999,8396 kg/m^3,
k_1 = - 0,6789645·10^{-4} (1/ ^{o}C),
k_2 = 0,907294338·10^{-5} (1/ ^{o}C^2),
k_3 = - 0,96456812·10^{-7} (1/ ^{o}C^3),
k_4 = 0,873702983·10^{-9} (1/ ^{o}C^4)

$\rho_{max} = \rho$(3,98 ^{o}C)= 999,971964 kg/m^3

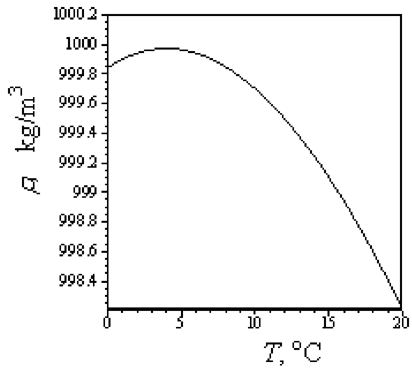

Figure 1. Density-temperature relationship of water

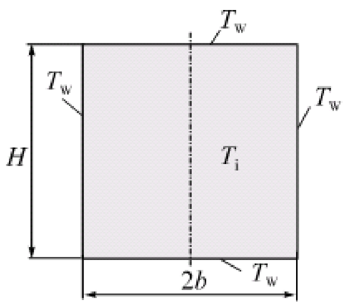

Figure 2. Schematic view of the considered problem

The physical properties of water used in the computations, except of the density in the buoyancy term, are assumed constant and they are evaluated at the mean temperature (T_{in}+T_w)/2. They are: the heat capacity c=4130 J/(kg·K), the thermal conductivity k = 0.541 W/(m·K), the viscosity $\mu = 1.114 \cdot 10^{-3}\ \mathrm{Pa \cdot s}$. Based on the given values, the thermal diffusivity of water is $a = k/(\rho_0 c) = 9.60633 \cdot 10^{-8} \mathrm{m^2/s}$. The values of

two basic dimensionless parameters describing the problem are: the Prandtl number, $Pr = \nu/a = 11.57$, and the Rayleigh number, which is defined on the basis of cavity height as:

$$Ra_H = \frac{g\left[\rho(5^o\mathrm{C}) - \rho(T_w)\right]H^3}{\rho(5^o\mathrm{C})\nu a} = 4.66 \cdot 10^4 .$$

Non-dimensional coordinates are: *X=x/H* and *Y=y/H* where *H*=0.016 m is the enclosure height, 2*b* is the enclosure width, and *B* is the unit enclosure length.

The non-dimensional time is defined as $\tau = \frac{t \cdot a}{H^2}$.

The problem to be considered is the motion and heat transfer which occurs when a mass of water, contained in a cavity, is cooled to near freezing. The problem is schematically shown in Figure 2. Initially, the water is assumed to be at temperature T_{in}=10 ºC. At time *t*=0, the walls of the cavity are abruptly cooled to the temperature T_w=0 ºC and maintained at T_w thereafter. It is supposed that the cavity is sufficiently long in the direction normal to the plane of the cavity for the motion to be assumed to be two dimensional. It is also assumed that the motion is laminar and also that the temperature difference (T_{in}-T_w) is sufficiently small so that the Bousinesq approximation may be made, which neglects density variation in inertial terms of the equation of motion, but retains it in the buoyancy term of the vertical equation.
The problem under consideration is symmetrical and it was found advantageous to reproduce computer results at a given time on single graph with the flow pattern on the right half of the cavity and the isotherms on the left half. The numerical computation is conducted for the half of the domain (*b*x*H*), on the uniform grid 40x80 CV. The total integration time ($\tau = at/b^2 = 0.201$, t_{uk}=134 s) was so long that all the volume of water is cooled under the temperature of 4 ^{o}C, and selected time step was $\Delta\tau$=0.01, Δt=6.67 s.

3. Results and discussion

The unsteady cooling of water in a rectangular cavity is simulated and the results are shown in Figure 3. Figure 3 shows isotherms (on the left hand side of the domain) and streamlines (on the right hand side of the domain) in selected time steps (τ=0.010; 0.060; 0.110) during natural convection in the water. Figure a) is obtained by the numerical computation using developed software at FAMENA, while b) shows figures obtained in the computations using FLUENT. The isotherm 4 ^{o}C is marked in the figures by the number 4 and it shows the location of the maximal water density.

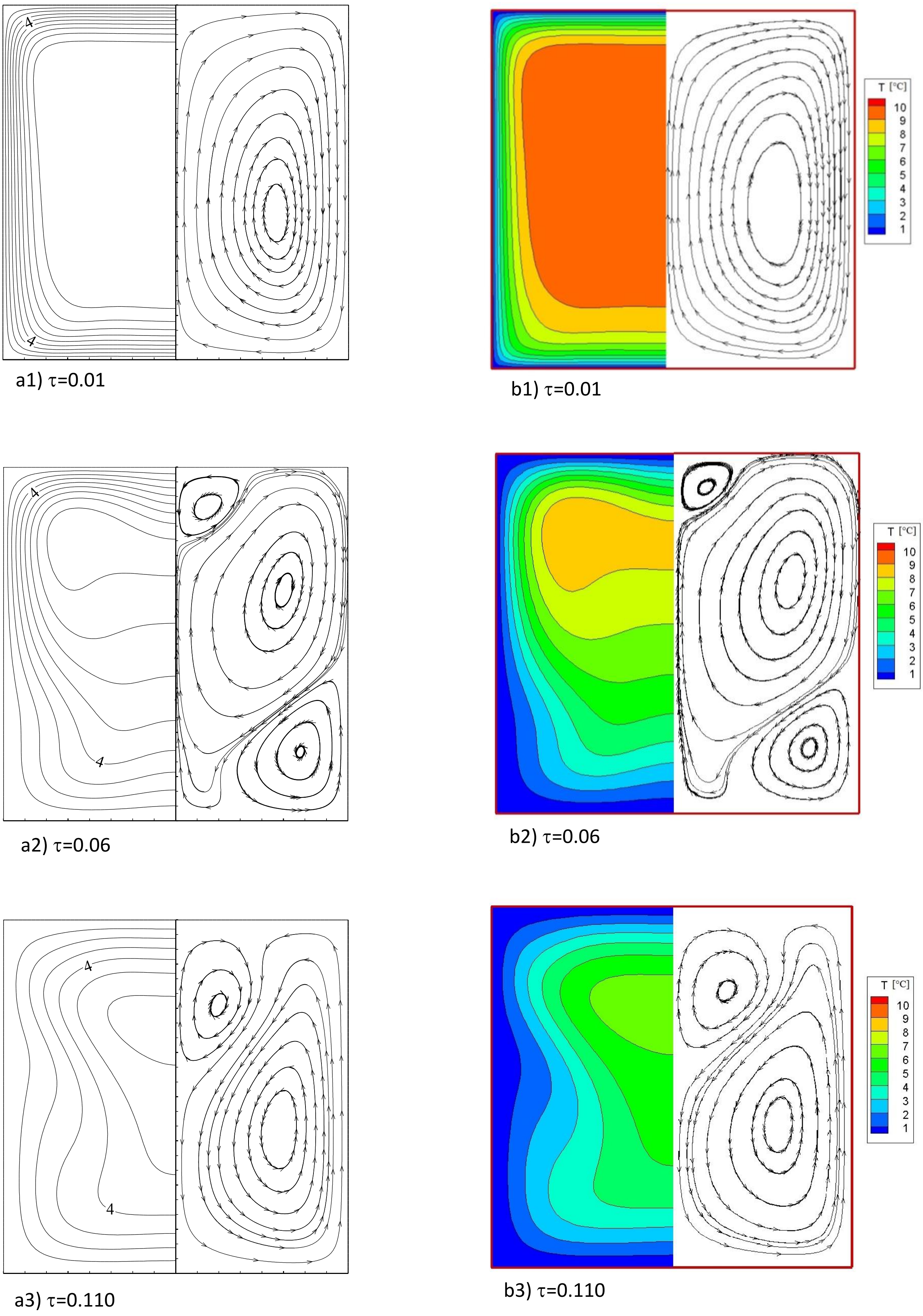

Figure 3. Isotherms and streamlines during natural convection in water, results obtained by a) software developed at FAMENA, b) FLUENT

At the very beginning of the cooling process, heat transfer is dominated by conduction. A motion of the boundary layer type is firs set up near the walls, this movement gradually extending inside the cavity. At the end of this initial regime, (τ=0,010), motion has become important over the entire cavity. One, clockwise rotating vortex, is dominant in the considered right half of the cavity (Fig. 3a1 and 3b1). It can be seen, from the streamlines shown in this picture, that the cooler water is transported downward while the warmer water in the core region is transported upward. Thus, a large part of the body of water has become thermally stratified with the isotherms sparsely spaced near the bottom wall and closely spaced near the top one.

This configuration indicates qualitatively that the local heat transfer is higher at the top wall than at the bottom one. It is noted, from the Figure 3.a1 and 3.b1, that at the bottom of the cavity, in the layer of fluid included between the 4 °C isotherm and the 0 °C bottom boundary, the buoyancy force changes sign, and the flow field is potentially unstable. Thus, the intensity of flow near the bottom remains rather weak until the vertical density gradient becomes sufficiently large. The unstable layer than grows and additional pair of vortices rotating opposite to the existing earlier one appears, marking the beginning of the inversion process.

With the progression of the cooling process, the lower vortex appearing on the right half, gradually increases its intensity and displaces the upper vortex. The cooler water located near the vertical wall and between the two counter rotating vortices is carried directly into the core region and disturbs locally the flow field as it can be seen by the distortion of the isotherms. Furthermore, due to the combined action of the counter rotating vortices, some of the warmer core water is carried downward in the lower portion of the cavity. It results from this motion that the heat transfer rate at the lower wall improves subsequently.

At τ=0,110, Figures 3.a3 and 3.b3, show that the original clockwise vortex has almost completely been engulfed by the already strong vortex grown from below. The original clockwise circulation is completely reversed, indicating that the flow field inversion process has come to the end. It can be seen that the relatively warm core has moved in the lower region and that the stratification of the water is now characterized by weak gradients at the top of the cavity and strong gradients at the bottom.

It is of interest to note that the vortex motion at the beginning and at the end of the cooling process although opposite in direction are similar in character. Results obtained for higher values of time show that the momentum of the eddy motion is slowly dissipated by the opposing viscous forces that the fluid motion become more and more minute. In addition to the two most significant vortices already discussed, some other eddies of very small intensity are also present in the corners of the half cavity. It is true that the existence of artificial corner cells, caused by numerical computation, has been reported in the past in literature. However, the size of the grid mesh, used in computation by software developed at FAMENA, has been chosen to avoid this problem.

4. Conclusion

The conclusion from the results obtained in this study can be written as follows:

1. Convective heat transfer is greatly influenced by the presence of density maximum in the convective fluid.
2. When the temperature corresponding to the maximum density is between T_{in} and T_w, the flow pattern and temperature field which start in a way comparable to the linear natural convection tend to a final state which corresponds to as completely revered situation in all aspects.
3. The results obtained by the software for the computation of flow and heat transfer during the phase change process, developed at the Faculty of Mechanical Engineering and Naval Architecture are in very good agreement with the results obtained by FLUENT, which confirms the accuracy of the built models.

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EXPERT SYSTEM FOR FIXTURE PLANNING AND DESIGN FOR BOX- SHAPED PARTS

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Abstract
In this paper a short descripiton of an expert system for setup and fixture planning and fixture design is presented.

Keywords
Computer Aided Fixture Design (CAFD), Process Planning, Fixture Planning

1. Introduction

The technological planning can be broken down into several steps (Figure1): (1) setup planning and conceptual design of fixtures; (2) operation planning: (3) fixture configuration and design.

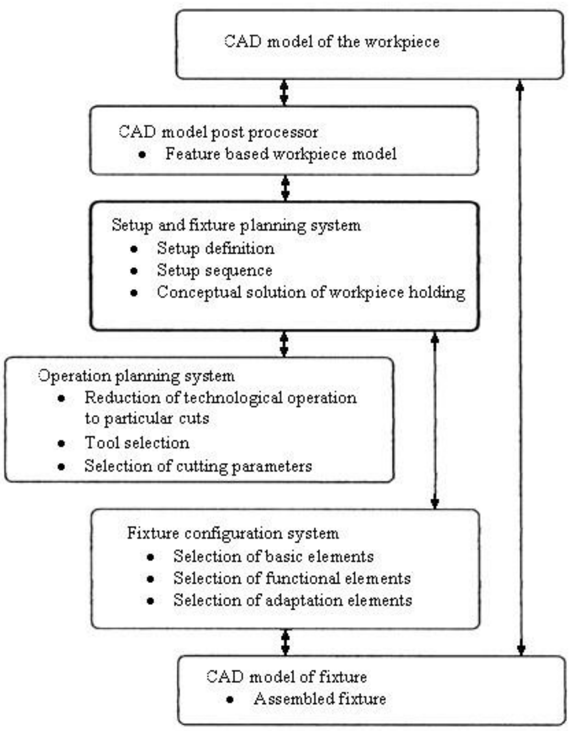

Figure 4 Integrated Process Planning and Fixture Planning System

The setup planning and conceptual design of fixtures is one of the most complex intellectual tasks in the process of industrial design and can be automated only with great difficulty. The reason is perhaps that the existing knowledge for the fixture solution is not available in explicit form as formulas, logical diagrams, or well-defined processes. Some of the major achievements in this field are listed below. 0 presented the FIXES system for setup and fixture planning for prismatic parts. It is a subsystem of the PART CAPP system which is the first complete expert process planning system to be commercialised and covers most of the process planning functions. The approach of 0 provided a short description of a Setup planner, and a more detailed description of a Fixture planning program. 0 presented an automated fixture design system in which the fixturing surfaces are automatically determined based on geometric and operational information. 0 offered a method for setup planning and setup sequence optimising by applying genetic algorithms. 0 applied case-based reasoning for process planning for prismatic parts where the clamping device is a vice. 0 developed a method which deals with simultaneous grouping of machining operations in the setup and selects adapted fixturing solutions. 0 presented an integrated setup and fixture planning system that sets out from the STEP (Standard for Exhcahnge of Product model data) format model of the workpiece. Several researchers have employed modular fixturing principles to generate fixture designs.

Although numerous CAFD (Computer Aided Fixture Design) techniques have been proposed and implemented, fixture design still continues to be a major bottleneck in the integration of CAD (Computer Aided Design) and CAM (Computer Aided Manufacturing) activities. With the review of the new method for fixture planning, developed for box-shaped parts machined on four-axis horizontal machines, we wish to contribute to overcoming the difficulty.

2. The IGES postprocessing / SUPFIX preprocessing module (IPPO)

Nowadays product design is mainly done with the help of some kind of 3D modeling software. Since different software packages stores the models made with them in a little bit different format, several so-called neutral (platform independent) file format standard have been developed. The most commonly used are STEP and IGES (Initial Graphics Exchange Specifications). Our system contains a module which can open CAD models saved in IGES format, and from that data set regenerates the curves and surfaces of the model, and visualize them. This module examines curves and surfaces, picks common curves and surfaces they belong, and examines if they form a machining feature. This module can recognize the features shown in Figure 5, these features are most frequently present on box-shaped parts, especially on gearbox casings.

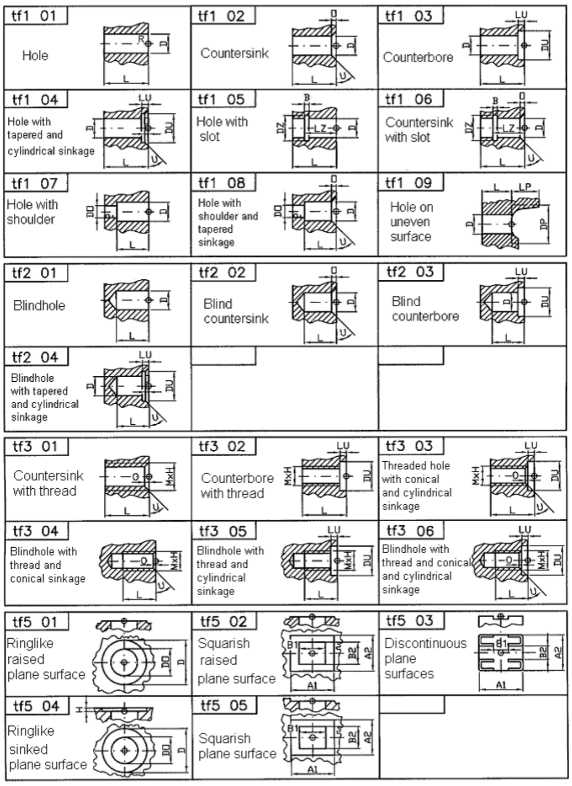

Figure 5 Most common features on gearbox casings

The program at first looks for common circular or elliptical arcs and investigates if they are part of any feature marked with tf 1.., tf 2.. or tf 3.. . Then it examines plane surfaces and looks if there are such coplanar surfaces that could serve as supporting, locating or clamping surfaces. Finally from those surfaces that do not belong either of above mentioned two groups, and are not hindered (less than 40% of their surface area is covered, so they could be used for locating or clamping) the program makes stand alone features (one surface features). Of course besides recognizing features, the program extracts their characteristic parameters like diameter or length, etc. The most important parameters of each feature are also shown in Figure 5

After feature recogniton we can define which features should be machined. Technologycal requirements like IT class and surface roughness can be determined, as well as whether or not a surface should be threaded. If a feature is selected and the "tolerances" button clicked on, then another feature may be selected, and position or distance tolerance between them prescribed. When all technological requirements are defined we store all data in such a form that the next module (SUPFIX) can process. In other words the data stored in the form shown in Figure 6 are converted and stored in form as shown in Figure 7

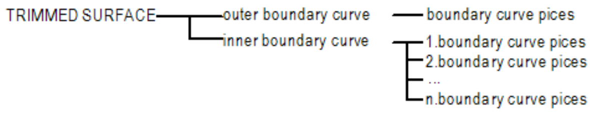

Figure 6 Data structure of IGES files

FEATURE constructional data(side, position, feature type, feature sequence number, mach. requir.)
geometrical data (size, diameter, angle ...)
tolerances

Figure 7 Data structure of IPPO files

3. The Setup and Fixture Planning module (SUPFIX)

This module uses data stored by IGES postprocessing module. It analyzes machining requirements and relationship tolerances, and selects eligible supporting side and supporting type. First it tries to find such supporting surface that ensures the machining of all tolerance connected surfaces in the same setup (the ideal technological position). If this succeeds, it checks if there are eligible locating and clamping surfaces. If it finds eligible surfaces, it gives us a proposal. The process engineer can accept or refuse that proposal. In case of rejection the program tries to find another solution. If the ideal technological position strategy does not bring fruits, the program tries to find such a solution at which at least the strictly connected surfaces are machined in the same setup. If this attempt fails, the program decomposes a strictly connected side and all strictly connected surfaces are machined in the same setup, while the loosely connected surfaces in the other setup. This solution needs special fixture solution, which ensures that the part can be partly machined on the supporting side too. If the program is unable to find such solution, then some strictly connected surfaces must be machined in different setups. In that case complicated and expensive fixtures are needed.

During the analysis of a feature from the aspect of supporting eligibility the program performs shape, size, machining requirements and tolerance relationships analysis. The locating surface candidates are investigated from the aspects of shape, size and location. The clamping surface candidates are investigated from the aspects of shape, size, location and force closure.

4. The Fixture Configuration module (FIXCO)

In the possession of (by the SUPFIX module) proposed supporting, locating and clamping surfaces, this module tries to build a modular fixture that is eligible for precise and stable clamping of the workpiece. In first step the program selects the proper ground plate and (if needed) supporting elements, then puts the workpiece on the centre of the ground plate, then selects locating elements depending on the kind, height and orientation of locating surfaces. In the following step the program moves the workpiece as the locating elements require. After that the program tries to place clamping elements over such ground plate holes which are close enough to the clamping surface contour to ensure stiff clamping. If this attempt does not succeed, then adopting elements should be used. Adopting elements are used to increase the height of functional elements, or when we have to move the functional elements along a given direction, in order to be at the ideal position. But by applying adopter elements the fixture becomes complicated, increases the fixture weight and decreases the stability and accuracy. So if possible, it is better to design fixture with possible least number of elements.

To make the process planning easier, the program visualizes not only the 3D image of the fixture, but in a separate window it shows the 2D views of the fixture from top and side directions. This way it is easier to notice if any element is not in the right position. In such cases the process engineer can grasp the element with the mouse and move it to the right place.

5. Implementation and test example

The Integrated Process Planning and Fixture Planning System is made up of several modules presented in Figure 1. All modules are implemented in Visual Prolog programming language. The feature-based workpiece model, which is created by the CAD model post processing module, is the input of the Fixture Planning System. Based on this input the system generates an acceptable solution for setup(s) and fixture(s) definition. Search for a fixture solution is carried out automatically, but the solution offered by the system must be approved by the user. This may primarily be necessary regarding the selection of the clamping points, as it may happen that the clamping element obstructs the machining and, at its current level of development, the system is unable to detect this kind of inference.

The approach described above has been tested on industrial parts. Presented in *Figure 8* is an example of a typical workpiece.

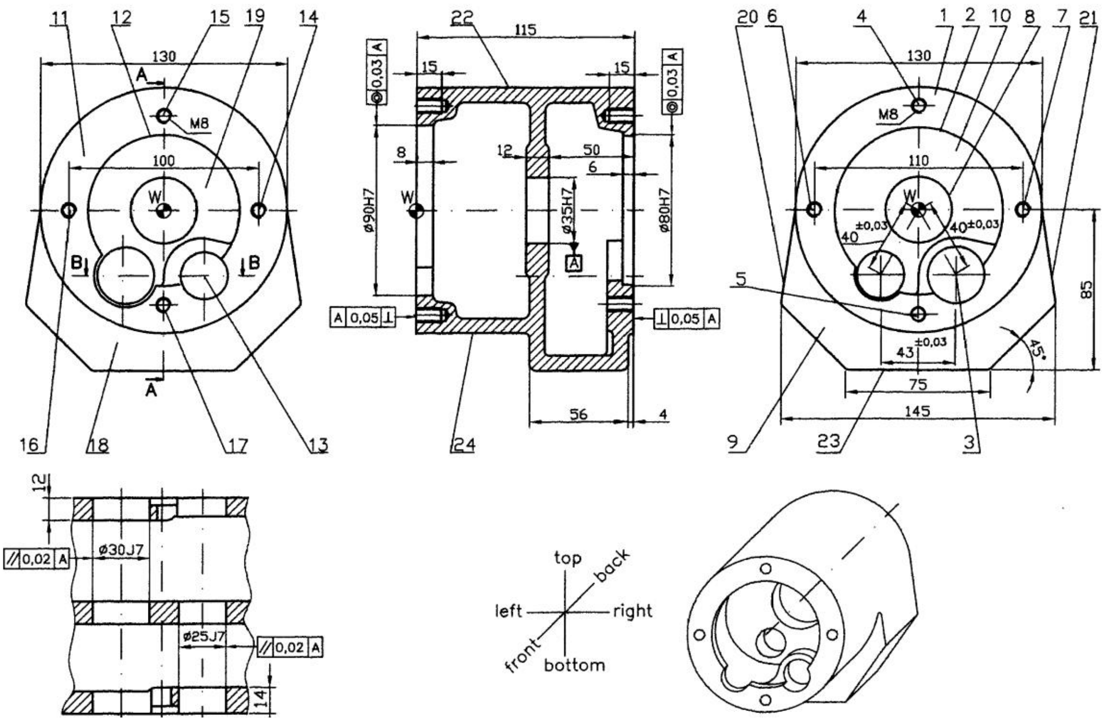

Figure 8 Test example

The surfaces (features) of the workpiece are marked with numbers on the drawing. With geometrical – and tolerance analysis of the workpiece, the following facts are known: Strictly connected features of the workpiece are the features marked with the numbers 2, 3, 12 and 13. Loosely connected features are marked with 1 and 11. Respectively the front – and the back faces are strictly connected faces, and the top, bottom, left and right faces are free faces. In the first step, the system tries to solve the main clamping, applying the first strategy, namely the main clamping fixture solution for the technologically ideal position of the workpiece. The workpiece can be placed in the workspace of the machine tool in the technologically ideal workpiece position if, for example, the plane locating face is at the bottom because the bottom face and top faces are not tolerance-related faces, but the bottom face is not suitable for plane locating. Hence this attempt will fail. The same problem occurs by supposing the plane locating face is the top, left, or right face. That is why this strategy must be skipped and the second strategy be applied.By using the second strategy, namely the Fixture solution based on disregarding the loosely tolerance-related faces, the same problems are likely to occur as with the first strategy.After the failure of both the first and second strategies the system will apply the third strategy, which is the Fixture solution based on the reduction of a strictly tolerance-related side into loosely tolerance-related surfaces and strictly tolerance-related surfaces. According to this strategy the plane locating type is vertical with ability of partial machining of the locating face. The system checks the suitability of possible workpiece positions for locating and clamping. At this strategy the system looks for supporting faces only among the strictly connected faces. If it is assumed that the plane locating face is the front face, the system will yield the fixture solution for the main clamping (*Figure 9*). The plane locating surface is the feature marked by number 1. The side locating is possible by using two threaded joints denoted with number 4 and 5 on the front face. The clamping is done by screws and threaded joints on the front face denoted with number 4, 5, 6, 7. The features on the front face denoted with number 1, 4, 5, 6 and 7 will be machined in additional clamping while the strictly connected features 2 and 3 will be machined in the main clamping together with the other strictly connected features of the workpiece. This is possible only through the opening in the fixture body (*Figure 10*).

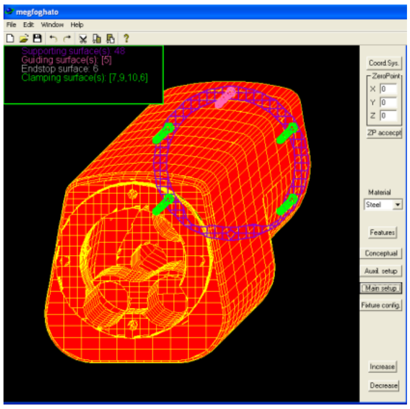

Figure 9 The proposed conceptual solution for main setup

Figure 10 The realised fixture for the main clamping with the workpiece

6. References

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TESTING OF MECHANICAL PROPERTIES OF COMPOSITE FROM RECYCLED MATERIALS

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Abstract
This article deals with testing of composite from recycled materials. Composite is composed by mixing of two components, the matrix is thermoplastic polyvinyl butyral, is part of windshields as security film, after recycling. The main part of composite is fabric from used tires. This composite with 50% and 80% of fabric was testing of tensile test, before and after climate chamber also. The results for tensile strength of 50% fabric in composite materials is 7, 223 N. mm^{-2}, after 320 hours is 10,995 N.mm^{-2}.The tensile strain at tensile strength is 13,583 %, after 320 hours is 8,426 %. For a composite material with containing 80% is value of tensile strength 5,086 N.mm^{-2} before testing in clima chamber and 7,026 N.mm^{-2} after 320 hours. The tensile strain at tensile strength for 80% of textiles is 3,158 % and after clima chamber is 3,907 %.

Keywords
Used tires, fabric, PVB, composite, mechanical properties

1. Introduction

The tires production is worldwide increasing due to the development of individual mobility. Therefore the quantity of tires to be processed as waste is increasing. The most important products of the industrial treatment of used tires are rubber pellets, steel and fabrics. Different technologies are known for separation and further applications of rubber granules and steel. The main parts of resulting products are rubber granules. Because of its thermal insulation and sound insulation properties it has already found its place in the road construction. For steel there is a well-established complete industrial recycling process. Used tires or tires whose parameters do not meet the requirements are specified by the relevant provisions of the safety road [1-4]. The used tires are gaining valuable raw material, which is rubber crumb. It has wide use as an ingredient in asphalt, concrete filler, base layers of roads, railway crossings, coatings, paints, running tracks, playgrounds. Separated steel parts are also used in the engineering and metallurgical industries [1-4].

Remains the last component from used tires is fabric. The important fabric properties are sound absorbability, the absorption capacity, thermal properties, flexibility and elasticity [4,5]. Rubber materials are processed by separating devices into small pieces or granules, which are the following added to asphalt, concrete products and the railway sleepers. The disadvantage of these solutions is inefficient evaluation of rubber materials and possible environmental hazards at their disposal. [6-8].

2. Materials and Methods

Fabric (Fig.1) is a component of the separation of the other two parts of the accumulated loose material with containing phase of fabric with a length of 0,3 mm to 3,33 mm and a diameter of 2,8 μm to 30 μm with a length of rubber shares from 1 mm to 3 mm and the residual wires with a length of 2 mm to 10 mm.

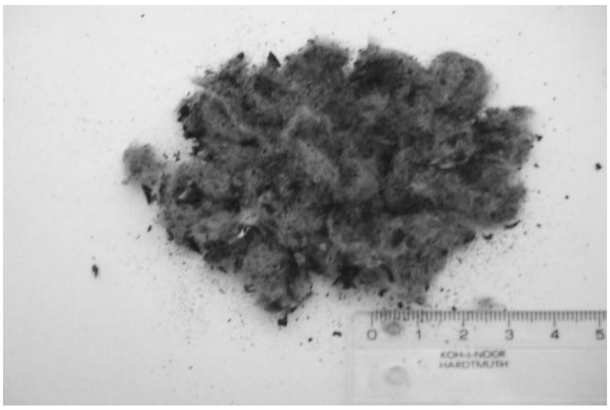

Figure 1.Fabric from used tires [4].

The matrix is polyvinyl butyral produced by Schirmbeck Ltd., Germany. Polyvinyl butyral was arising from the recycling of car glass.

We used the recycled material in the flakes shape, dispersed, spherical, and spatially oriented with size of 1-25 mm, (Fig. 2). The first and basic task is the separation of the fabric components of undesirable contaminants, namely rubber dust, cord and metal residues.

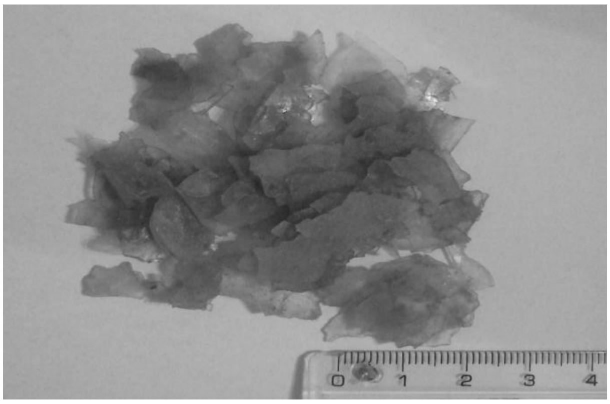

Figure 2. Recycled polyvinyl butyral (PVB) [4].

The next step is the homogenization of the components (PVB and fabric), which ran in the kneading machine at a prescribed temperature and time. After the material homogenization is pressed test board (Fig.3) in the press machine, for a prescribed pressure, temperature and time. After pressing the test boards are tested at the tensile test, with the size 150x68x3 mm and according to Standard EN ISO 527-3 (Type 5) [9].

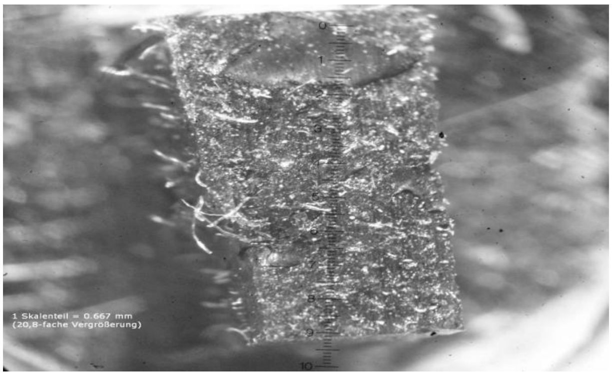

Figure 3. Composite materials, 40x zoomed (mixed PVB and fabric from used tires) [4].

Tensile test evaluates the strength of the material strength. The principle of the stress test is a test of material's body to the point where there is a rupture of the sample [2,10]. The tensile test was conducted on the device Zwick Z020 Universalpruefungsmaschine [1,11]. Tensile test was carried out according to Standard EN ISO 527-1:1996 (Table 1).

Table 1. Characteristics of tensile test [12].

Maschine	Universalpruefungsmaschine
Maschine Type	Zwick Z020
Software	Test- Expert
Max. Force	20 kN
Young´s modulus testing speed	10 mm.min^{-1}
Speed Test	100 mm.min^{-1}
Standard	DIN EN ISO 527-1

3. Results and Discussion

Tensile test was conducted on the device Zwick Z020 - Universalpruefungsmaschine (Germany). After the required data into the programs Test-Xpert (as specimen thickness, width of the sample) (measurement of thickness and width of samples) is transferred through a digital measure at least on 6 different locations on the sample. In the jaw of device Zwick Z020 are still attached samples, that were selected out of the bolt release. Each sample was tested to a tensile test. The following tables (Table 2 and Table 3) show the statistical data. We calculated the tensile test for each composite materials [4,9].

Table 2. Tensile test results for material with 50% PVB a 50% fabric

Series	Young´s modulus [N.mm^{-2}]	σ_Y [N.mm^{-2}]	ε_y [%]	σ_{max} [N.mm^{-2}]	ε_{max} [%]	σ_B [N.mm^{-2}]	ε_B [%]
$\bar{x}$	356	7,222	13,203	7,223	13,585	6,335	15,843
s	72	1,136	5,845	1,136	6,277	1,388	7,087
v	19,740	15,730	44,270	15,720	46,210	21,910	44,730

Table 3. Tensile test results for material with 20% PVB a 80% fabric

Series	Young´s modulus [N.mm^{-2}]	σ_Y [N.mm^{-2}]	ε_y [%]	σ_{max} [N.mm^{-2}]	ε_{max} [%]	σ_B [N.mm^{-2}]	ε_B [%]
$\bar{x}$	283	5,086	3,158	5,086	3,158	6,835	4,614
s	80	3,523	2,366	3,523	2,366	0,645	1,994
v	28,360	69,260	74,910	69,260	74,910	9,440	43,220

Composite material on the fabric base with polyvinyl butyral was tested in climate chambers (Table 4). Climate chambers is a device where the samples are subjected to cycles in certain ultraviolet radiation, temperatures between minus and plus values, relative humidity [6], exposure to water (spraying water samples) and condensation. In Fig.4 is to show relation of tensile strength σ_{max} , tensile strain ε_{max} at tensile strength and Young's modulus on % ratio of fabrics.

Table 4. Results for composite with 50% and 80% fabric, measurement before and after testing in climate chamber

Measu-rement	50% Fabric		80% Fabric	
	Before	After	Before	After
Young´s modulus [N.mm^{-2}]	365	267	283	347
σ_{max} [N.mm^{-2}]	7,223	10,995	5,086	7,026
ε_{max} [%]	13,583	8,426	3,158	3,907

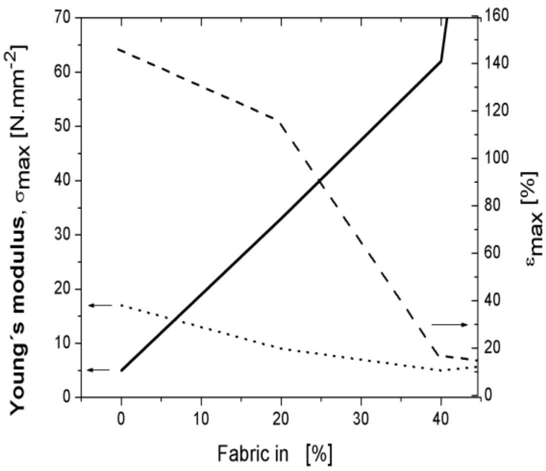

Figure 4. Relation of tensile strength σ_{max}, tensile strain ε_{max} at tensile strength and Young's modulus on % ratio of fabrics

Legend:

(Young´s modulus ——, σ_{max} . . . . , ε_{max} - - - - -)

The actual temperature of the sample depends on the type of material tested. The composite material was tested with a sample of fabric 50% and 80% according to the EN ISO 4892 [5,11]. The character of the mixing process as well as the emerging nature of the mixture depends on whether the mixed components are completely miscible, partially miscible or completely immiscible. The results for composite with 50% and 80% fabric from used tires are presented in Table 4. The value for composite with 50% fabric and 50% PVB, tensile strength is 7,223 N.mm^{-2} before a climate chamber and value of σ_{max} is 10,995 N.mm^{-2} after 320 testing hours. The value of the elongation is after testing in climate chamber 13,583 % and before of testing 8,426%. For a composite material with 80% of the fabric is value of tensile strength 5,086 N.mm^{-2} before tested in climate chambers and 7,026 N.mm^{-2} after 320 hours. The value of elongation for 80% textile share is 3,158% and 3,907% after 320 test hours in climate chambers.

4. Conclusion

From previous testing of composite with 50% and 80% of the fabrics from used tires is likely that the values of elongation and ultimate tensile strength after 320 hours in climate chambers under the prescribed conditions aren't different. It means that the material is stable. Homogenization of both materials was good mixed in kneading machine. Testing of fabric material from used tires and thermoplastic PVB in climate chambers after 70 and 320 hours we founded the tensile characteristics of the composite material with 50% of the fabric components. After analysis, it is known that Young's modulus before and after climate chambers decreases and subsequent increases, due to the action set conditions and also the fact that the samples are not perfectly formed from the homogenized material, due the presence of rubber components in a total volume of the mixture. This test examined the composite material with a fabric component which is different from the properties of matrix composite and is to withstand the prescribed test conditions. Use of such secondary raw materials, protects the environment and reducing the use of primary raw materials for manufacturing products with comparable properties.

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IMPROVING DYNAMIC STRUCTURE BEHAVIOR USING A REANALYSIS PROCEDURES TECHNIQUE

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Abstract

The present paper deals with the problem of dynamic improving characteristics for a sub-structure of bucket wheel excavator. The procedure is concerned with the analysis of the distribution of potential and kinetic energy in elements of the structure, which gives prediction for which elements need reanalysis.

Keywords:

dynamics, reanalysis, FEM, potential energy, kinetic energy

1. Introduction

Nowadays structure design requirements have broad definitions because of high technology industry.

Dynamic analysis include dynamic properties such as vibration level, resonance range, response properties, eigenvalues, dynamic stability and modal forms. To avoid dynamic problems, some modification will be done for structure in process of reanalysis. Reanalysis is a technique through which the dynamic response of the structure is improved. Finite element method is a powerful method to perform these processes using simple procedures. Modeling of complex structures using finite elements method is a helpful approach in solving problems in short time with reliable results.

2. Theoretical consideration

For the system with no damping and no external force, the equation of motion in the matrix form is:

$$[M]\cdot\{\ddot{Q}(t)\}+[K]\cdot\{Q(t)\}=\{0\} \tag{1}$$

Then, the eigenvalues of the previous differential equation for r-th mode can be expressed as:

$$[K]\cdot\{Q_r\}-\lambda_r[M]\cdot\{Q_r\}=\{0\} \tag{2}$$

Where λ_r - is the r-th eigenvalue, and Q_r - is the r-th eigenvector for the structure.

Now, by multiplying the left side of equation (2) by transposed value of r-th eigenvector and divided by 2 one can get:

$$\frac{1}{2}\{Q_r\}^T[K]\{Q_r\}=\frac{1}{2}\lambda_i\{Q_r\}^T[M]\cdot\{Q_r\} \tag{3}$$

Equation (3) is the balance equation of potential and kinetic energy for a structure in main modes of oscillation.

The kinetic and potential energy of the structure on r-th main oscillation mode is the sum energy of all elements structure modeling and can be represented as:

$$\begin{aligned} E_{k,r} &= \sum_{e=1}^{N}\left(e_{k,r}\right)_e = \frac{1}{2}\sum_{e=1}^{N}\omega_r^2\{q_r^s\}_e^T[m]_e\{q_r^s\}_e \\ E_{p,r} &= \sum_{e=1}^{N}\left(e_{p,r}\right)_e = \frac{1}{2}\sum_{e=1}^{N}\{q_r^s\}_e^T[k]_e\{q_r^s\}_e \end{aligned} \tag{4}$$

Where are:

$\left(e_{p,r}\right)_e=\frac{1}{2}\{q_r^s\}_e^T[k]_e\{q_r^s\}_e$ - potential energy of e-th element on its r-th main oscillation mode,

$\left(e_{k,r}\right)_e=\frac{1}{2}\omega_r^2\{q_r^s\}_e^T[m]_e\{q_r^s\}_e$ - kinetic energy of e-th element on r-th main oscillation mode,

$\{q_r^s\}_e$ - is the corresponding r-th eigenvector, of e-th element with s degrees of freedom.

Consequently, the dynamic analysis can be done according to the difference between potential and kinetic energy distribution (ep - e_k) through all structure's elements.

Basic formula for structure dynamic reanalysis is:

$$\frac{\Delta\lambda_r}{\lambda_r}=\frac{\frac{1}{2}\{Q_r\}^T[\Delta K]\{Q_r\}-\frac{1}{2}\lambda_r\{Q_r\}^T[\Delta M]\{Q_r\}}{\frac{1}{2}\lambda_r\{Q_r\}^T[M]\{Q_r\}}= \\ =\frac{\alpha_e e_{p,r}-\beta_e e_{k,r}}{E_{k,r}} \tag{5}$$

The previous equation has an important definition to understand the procedures of reanalysis and to define the position of elements that require modifications to improve the dynamic behavior of the structure. Because the denominator has the same value, the numerator is the main interest of analysis. Therefore, the natural frequency of the structure increases or decreases according to the values of α_e and β_e. When α_e has a positive value, hence increased rigidity, the natural frequency is increased. When α_e has negative values, hence decreased rigidity, the natural frequency is decreased. On the other hand, when β_e has a positive value, hence increased mass, the natural frequency is decreased. When β_e has negative values, hence decreased mass, the natural frequency is increased. Consequently, the modification (increase/decrease structure rigidity or mass) which will be done for the structure depends on the sign value of numerator in equation (5). The main point of improving dynamic behavior of the structure is increasing its natural frequencies and maximizing the interval between adjacent natural frequencies. Hence, study of energy distribution will be done for each element in the structure to determine places of modification.

2. Developed procedure of dynamic modification

Structural Dynamics Modification is a very effective technique to improve structure's dynamic characteristics such as natural frequency, mode shape and frequency response functions. Although this topic has been widely studied in the previous decades, the methodology of modification (reanalysis) of constructions is still under intense development. The dynamic behavior of the structure can be improved by predicting the modified behavior making some modifications parts like rigid links, beams, lumped masses, dampers etc The present paper shows Structural Dynamics Modification procedures that can be successfully applied for all types of constructions. These procedures have been applied on a complex real problem to improve dynamic response of the structure. The obtained results, by applying reanalysis procedure for the structure to determine places of modification.

The procedure which is used in this paper is concerned with distribution of potential and kinetic energy in all elements of the structure which gives predictions for reanalysis.

The following cases should be considered for reanalysis of similar constructions:

a) Elements in which the kinetic and potential energies (and the difference in their increase) are negligible with respect to other elements.
b) Elements in which the kinetic energy is dominant compared to potential energy
c) Elements in which the potential energy is dominant compared to kinetic energy
d) Elements in which the potential and kinetic energy exist and are not negligible in comparison with other elements.

The following algorithm is established based on the previous analysis as illustrated in the following steps:

Step 1: The observed structure is divided into appropriate number of finite elements for which kinetic and potential energies are calculated separately, on those main modes which are interest in the analysis.
Step 2: Comparing the values of potential and kinetic energy over zones or elements, as well as corresponding energy differences, based on which the following courses of analysis are formed.
Step 3: In elements for which is valid:
$e_{pr} \to 0,\ e_{kr} \to 0$, there are no possibilities for successful modifications with respect to increasing eigenfrequencies. These elements do not have significant effect on dynamic behavior of structure, but they might be suitable for other types of optimizations. In general, reducing the mass of those elements lightens the weight of whole structure without endangering its dynamical behavior.

Step 4: For those elements where $e_{pr} >> e_{kr}$, eigenvalues can be increased by increasing the stiffness of structure. The modifications to increase these values are not arbitrary, but they are done according to the principle of energy distributions through the elements of structure.

Step 5: For those elements where $e_{kr} >> e_{pr}$, eigenvalues can be increased by decreasing the mass of structure. Also, this operation can be done based on distribution of energy through the elements of structure. According to many criteria, decreasing of mass is a generally desired type of modification.
Step 6: Most often, elements appear in structure for which the values of $e_{kr},\ e_{pr}$ are not negligible. Therefore, the situation is more complex and those elements are suitable for reanalysis. In this case, the reanalysis of structure is done based on the differences in increases of potential and kinetic energy $\Delta e_{pr} - \Delta e_{kr}$ between modified and original system. The modification parameters α and β are independently calculated for each element. It has been shown that modification parameters depend on type of cross sectional area, type of material used, and boundary conditions.
Step 7: When the desired value of increase is achieved, it is possible to conduct the check of modified structure by running the software based on the finite element analysis, with modified parameters. Then, the evaluation of modified structure can be obtained based on new energy distribution schemes. If the difference of energy increase on the redesigned places is less than the previous that means that the procedure

converges, and vice versa. Convergence is the goal of every optimization procedure.

3. Case study

Bucket wheel excavators are complex systems, with numerous functionally important components. This wheel excavator is working in cement factory BFC Lafarge Beocin. In this paper the diagnostic of dynamic behavior of the bogie rotary excavator has been done in order to achieve the appropriate reconstruction. Figure 1 shows the first exact model which is the model of the original structure. Calculations of main modes of oscillation were performed using Abaqus [16] while the energy distributions using KOMIPS [17].

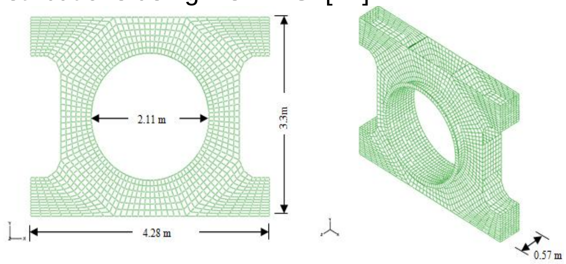

Figure 1: The existing structure of bogie rotary excavator.

This study consists of seven models for structure reanalysis. Model 1 is referred to the original structure. Figure2 shows the obtained results for the first mode of oscillation of this model (bending). Potential and kinetic energies have been calculated using Equations (4) and (5) and the differences in increment were determined, as presented in Figure 2.

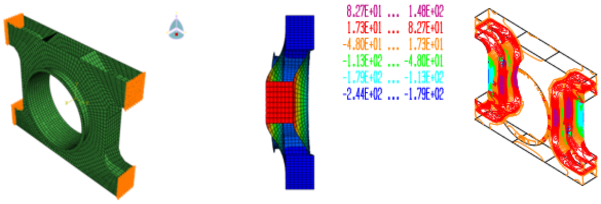

Figure 2: FEM of model 1.The first frequency is f_{01}= 63.132 Hz. Difference between potential and kinetic energy [Nm]

Model 2 represents the first proposed modifications for the structure. The additional materials were added around the hole in the center. Figure 3 shows the obtained results of this model. Based on the distribution of energy through the structure, it can be noticed that the zones which have positive values in the difference between potential and kinetic energy (red and Violet colors) require increasing in the stiffness. Therefore, the stiffness of the structure was increased in model 3 (figure 4) by increasing the distance between the upper and lower plates. According to the obtained results of model 3, it is clear that the dynamic behavior of the structure has been improved, where the value of the first frequency for this model is 92.993 Hz while the first frequency for model 1 was 63.132 Hz.

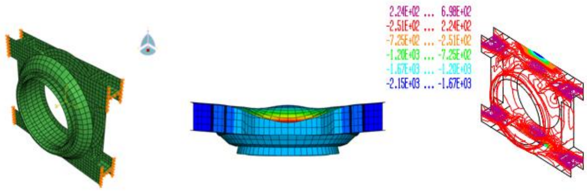

Figure 3: FEM of model 2.The first frequency is f_{01}= 88.975 Hz. Difference between potential and kinetic energy [Nm].

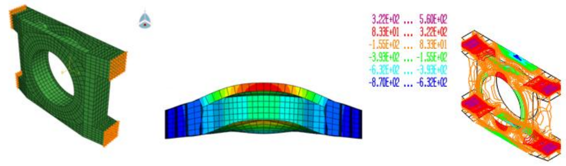

Figure 4: FEM of model 3.The first frequency is f_{01}= 92.993 Hz. Difference between potential and kinetic energy [Nm].

To get better results some modifications have been done to the structure,where both sides of structure were covered by additional plates. Figures 5, 6 and 7 show the effect of these modifications on models 4, 5 and 6.

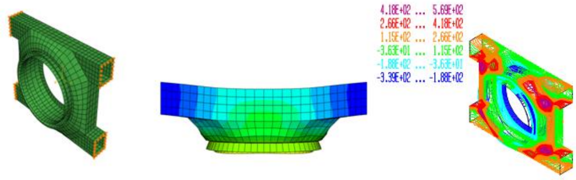

Figure 5: FEM of model 4.The first frequency is f_{01}= 101.88 Hz. Difference between potential and kinetic energy [Nm].

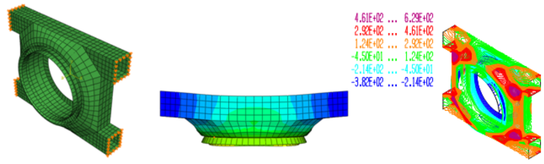

Figure 6: FEM of model 5.The first frequency is f_{01}= 107.4 Hz. Difference between potential and kinetic energy [Nm].

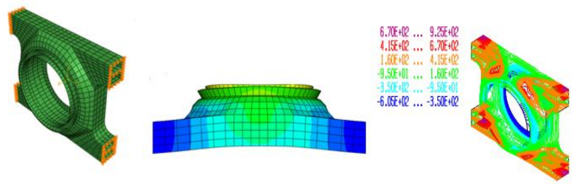

Figure 7: FEM of model 6. The first frequency is f_{01}= 129.42 Hz. Difference between potential and kinetic energy [Nm].

Model 7 is the final proposed modification model for the structure. The additional stiffeners have been added to the both sides of the Bucket wheel excavator as shown in figure 8. This model has the best results compared with other previous models. Figure 8 shows the obtained results of this model. The first frequency of this model is f_{01} = 143.72 Hz which is considered a higher value in all models.

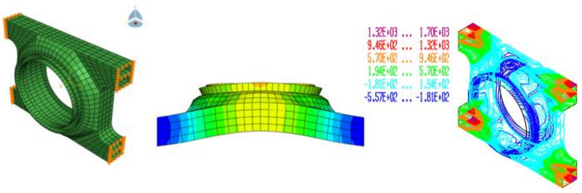

Figure 8: FEM of model 7.The first frequency is f_{01}= 143.72 Hz. Difference between potential and kinetic energy [Nm].

Although the high height of first frequency is a good criterion for improving structure's behavior, the difference between frequencies is also very important factor as mentioned before. Therefore, in order to observe the difference between adjacent frequencies, the first three frequencies have been determined for all models. The comparison between all models is shown in fig.9.

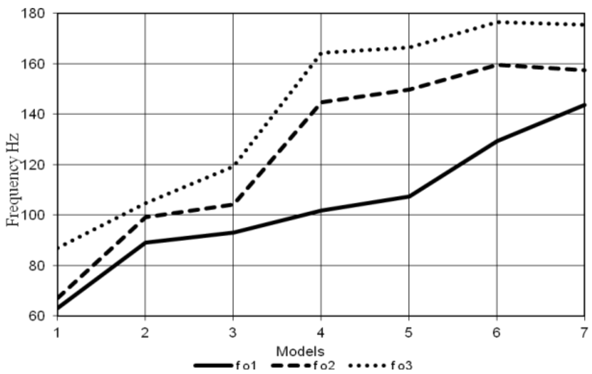

Figure 9: Comparison between models considering the differences between adjacent frequencies.

4. Conclusion

Distribution of potential and kinetic energy in main oscillation modes is the base methodology for improving dynamic behavior of structure using reanalysis procedures technique. Study of distribution of potential and kinetic energy of structure gives obvious prediction which elements need some modifications to achieve the best dynamic characteristics. Structure's dynamic behavior can be improved by making some geometrical modification through adding some parts, increasing/decreasing structure's weight by resizing some elements or changing used material. The main point of improving dynamic behavior of a structure is increasing its natural frequencies and maximizing the interval between adjacent natural frequencies.

The algorithm of reanalysis is derived based on energy distribution by considering the following aspect:

a) Elements in which the kinetic and potential energies (and the difference in their increase) are negligible with respect to other elements.
b) Elements in which the kinetic energy is dominant compared to potential energy.
c) Elements in which the potential energy is dominant compared to kinetic energy.
d) Elements in which the potential and kinetic energy exist and are not negligible in comparison with other elements.

According to the results obtained from the dynamic behavior of the bogie rotary excavator after the modifications had been done on the base structure, it can be clearly concluded that the study of distribution of potential and kinetic energy gives a clear definition for interest zones and elements for modifications.

The new solution of structure increases the first main mode about 2.2 times of the original structure. As result, the improving of structure's dynamic behavior was achieved.

5. Acknowledgment

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THE INFLUENCE OF QUALITY OF CORED WIRE ON THE PROPERTIES OF WELDED JOINTS OF MICROALLOYED STEEL NIOMOL 490K

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Abstract
The aim of this research was to homologize a new quality cored wire made of narrow steel strip and the core filled with metal powders and low molecular hydrophobic compounds. For testing specimens were made of micro-alloyed steel NIOMOL 490K. Welding of specimens was done in CO_2 shielding using the MAG method with two different quality cored wires. Tested were the mechanical and metallographic of the base metal, weld metal and heat affected zone. Results of testing of welds performed with new qualities of cored wires should define a new product in terms of welding - technological characteristics.

Keywords: micro alloyed steel welding, cored wire, mechanical properties of welded joints.

1. Introduction

In the last 20 years, in the world there is an increasing use of fine grained structural steels, which are used in all areas of technology, where high load capacity is required and where limited cross sections should transfer great force. These steels have low carbon content and are micro alloyed with alloying elements in small quantities to increase the yield stress from 400 to 1000 MPa. Fine grain structural steels are micro alloyed with aluminum, niobium, vanadium and titanium (Al, Nb, V, Ti) [1-3]. These elements form nitrides, carbides or carbonitrides and prevent the growth of crystal grains in the austenite region. Aluminum from 0.020 to 0.050% binds nitrogen into finely distributed nitrides, decreasing in grain size, increasing yield strength and providing resistance to brittle fracture. The addition of Nb, Ti or V either alone or in combinations of two or three elements also binds nitrogen into nitrides and with carbon forms carbides which provide finely spaced non-metallic inclusions. Niobium already forms carbonitrides at quantities of 0.005 to 0.010% and significantly increases the yield stress, but toughness deteriorates, so its effect must be coordinated with the correct choice of thermo mechanical treatment. Vanadium is added in the amount of 0.05 to 0.15% and has the same effect as Nb. Vanadium has a stronger effect on decreasing the grain size due to faster and easier production of VN and VCN than AlN [2,3]. Steel NIOMOL 490K is fine grained micro alloyed steel and has a minimal yield stress of Re = 490 MPa. The structure of the micro alloyed steel of high strength, obtained by process of thermo-mechanical treatment is fine-grained ferrite-pearlite. Choice of filler for welding fine grained structural steels is based on chemical composition and mechanical - structural characteristics of the base metal, welding process and projected requirements for the properties of welded joints [4]. The most important chemical elements in the filler for welding fine grained structural steels are Ni and Mo [10]. Nickel favors formation of needle-acicular ferrite. In solid solution it increases the resistance of the weld metal to brittle fracture. Addition of nickel over 1.5%, significantly increases yield stress due to shifts in the transformation of γ to α. Molybdenum is an important element in the filler because it decreases the temperature of transformation of α to γ, reduces the primary structure of the weld metal, increases the amount of acicular ferrite and removes the upper bainite, retaining the thin plates of primary ferrite in the weld metal base. This significantly increases the yield stress with favorable toughness [5].
Welded joint properties of micro alloyed steels, such as impact toughness and tensile strength are closely related to chemical composition, rate of solidification and recrystallization rate and microstructure [3,7]. Welding parameters such as current strength, voltage and welding speed define the heat input during welding. When welding fine grained steels in particular, into account should be taken the amount of heat introduced, too much heat causes slow cooling of the units which induces coarse grain formation and decrease in toughness and too small an amount of heat causes rapid cooling and occurrence of a tempered structure. In the heat affected zone dissolution of

carbide, nitride, carbonitride and austenite grain growth occur. After cooling the HAZ has a ferrite-pearlite structure and rearly bainite. The microstructure of the HAZ depends on the thermal welding cycle [3]. The microstructure of weld metal of fine grain steel joints can be made up of three modifications of ferrite. These are needle ferrite (acicular ferrite), polygonal ferrite (primary ferrite) and Widmanstatten ferrite, which occur due to different mechanisms of transformation and differently affect the strength and toughness of the welded joint. [3].

In this paper, presented are the results of experimental research of the effects of content of nickel and molybdenum in cored wires on the properties of welded joints of steel NIOMOL 490K [6].The main objective of this study was to homologize new quality cored wires marked IHIS PŽ Ni2Mo and IHIS PŽ Ni1Mo made of narrow steel strips and metal powder and low molecular hydrophobic compounds filled cores. Welding of samples was done in CO_2 shielding with MAG welding process. Mechanical properties of the base material and weld metal were examined. Metallographic tests of base material, weld metal and heat affected zone.

2. Materials and experimental details

For the experimental study of mechanical properties and microstructure of the weld metal of welded joints two types of quality cored wire were used, marking IHIS PŽ Ni2Mo (2.30 to 2.70% Ni and 0.2 -0.3% Mo) and marking IHIS PŽ Ni1Mo (0.70 - 1.00% Ni and 0.3 to 0.4% Mo) with a 3.8 mm diameter and a base metal for welding, steel NIOMOL 490 K. The chemical composition of the steel is given in Table 1, and its mechanical properties in Table 2.

Table 1. Chemical composition of NIOMOL 490K

wt.%						
C	Si	Mn	P	S	Al	Cr
0,10	0,41	0,57	0,008	0,002	0,042	0,53

Table 2. Mechanical properties of NIOMOL 490K

Direct.	Yield strength	Ultimate strength	Elong.	Impact energy
	$R_{m0,2}$ (MPa)	R_p (MPa)	A (%)	ISO-V (J)
L-T	576	694	28,1	242, 248, 263
T-L	571	699	22,8	245, 248, 255

L – longitudinal direction, T - transferse direction

Preparation of edges of experimental 12mm thick plates of micro alloyed steel NIOMOL 490K was performed at an angle of 60^o (for the MAG welding process in CO_2 shielding).

Welding of test samples was done in CO_2 shielding - the process MAG (Ar/CO_2 ratio 80/20) with cored wires IHIS PŽ Ni2Mo and IHIS PŽ Ni1Mo. Welding parameters are given in Table 3.

Table 3. Welding parameters

Welding process	Voltage (V)	Current (A)	Welding rate (cm/mm)	Heat imput (KJ/cm)
MAG	28	310	32	16-18

Spectrochemical analysis of the chemical composition of pure weld metal was performed using the OES method on the ARL 2460 apparatus. Yield stress, tensile strength and ductility of pure weld metal were tested on flat specimens with parallel and concave sides, on the AMSLER testing machine according to the standards SRPS EN 895 and SRPS EN 10002-1/1. Resistibility of the base metal, weld metal and heat affected zone to brittle fracture was verified by examining impact at room temperature while determining of impact energy consumption KV (J), using 10x10x55mm Charpy type specimens with the ISO-V notch to the SRPS EN 875 and JUS EN 10045-1 standards. Examination of the microstructure of the base metal and welded joints was carried out under a light microscope according to SRPS EN1321 standard. Etching of samples was performed in 3% nital. Examined were the structure of the base metal, weld metal and heat affected zone.

3. Results and discussion

In table 4 shown is the chemical composition of pure weld metal of welded samples No.1 with cored wire IHIS PŽ Ni_2Mo and sample No.2 with cored wire IHIS PŽ Ni1Mo. Control of the composition of the weld metal was done so the content of Ni and Mo could be connected with the microstructure of welded joints.

Table 4. Chemical composition of pure weld metal

Chemical composition, wt. %	No. 1	No. 2
C	0,07	0,07
Si	0,27	0,26
Mn	1,120	1,047
S	0,012	0,013
P	0,012	0,012
Ni	2,598	1,192
Mo	0,233	0,326
Ti	0,020	0,023
Al	0,016	0,015

The values of yield stress, tensile strength and elongation of weld metal are shown in Table 5.

Table 5. Yield stress, tensile strength and elongation of pure weld metal

Spec.	No.1	No.2	No.1	No.2
Test specimen type	With paralle l sides	With sunk sides	With parallel sides	With sunk sides
Dimens. specimens a x b (mm)	12x20	12x24	12x20	12x24
Yield stress (MPa)	540	520	570	564
Tensile Strength (MPa)	670	630	700	690
Elong.(%)	>24	>24	>22	>22

Ni content of over 1.5% in the weld metal in sample 1 influenced increase in the value of yield stress and tensile strength compared to sample 2 with lower Ni content. Higher content of Ni favored formation of a higher share of needle - acicular ferrite in the weld metal base in sample 1. These values were confirmed by metallographic examination of samples under a light microscope.
The structure of the weld metal for both samples was dendrite pearlite - ferrite with acicular ferrite. Mo content of 0.2-0.3% in the weld metal of both samples further influenced fragmentation of the primary structure of the weld metal. Molybdenum with Ni in both samples positively influenced formation of acicular ferrite. At the same time eliminated the formation of upper bainite in the weld metal, which increased the yield stress of the weld metal while achieving favorable toughness.
In Table 6 shown are values of consumed impact energy. Based on the fracture properties of the weld metal and heat affected zone, it transpires that the fracture toughness of the heat affected zone is greater than the fracture toughness of the weld metal.

Table 6. Impact energy of pure weld metal

Spec.	Position of notch	Impact energy KV [J] at +20°C		
		1	2	3
1	WM	198	218	208
1	HAZ	280	246	260
2	WM	159	173	184
2	HAZ	249	225	234
PM	PM	291	304	291

The measured values are consistent with the microstructure. Impact energy consumption on all the samples are quite uniform, indicating that the weld metal and heat-affected zone have no local brittle zones. The highest toughness values were achieved in the weld metal and heat affected zone with cored wire IHIS PŽ Ni2Mo. The increased nickel content has favorably affected the increase in toughness.

Figure 1. shows the microstructure the base metal. The microstructure of the base metal is a homogeneous fine-grained ferrite - pearlite, which is characteristic of the steel NIOMOL 490K of high strength.

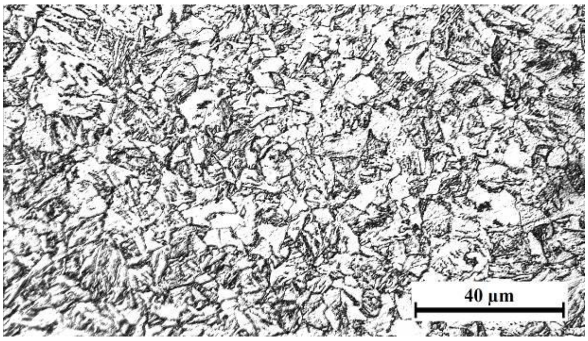

Figure 1. Microstructure of base metal, 500x

Figure 2 shows the microstructure the welded joint of sample No. 1, which is identical to the microstructure of the welded joint of sample No. 2.
The figure 2 shown relate to: a) fusion line, b) a transitional zone between the HAZ and weld metal and c) weld metal. In the heat affected zone microstructure is fine grained, ferrite - pearlite with spheroidized pearlite, which corresponds to the normalized structure of the heat affected zone. None of the samples in the heat affected zone had the brittle phase bainite. Along the fusion line and HAZ grain growth and presence of bainite were not detected, micrograph 2a).The microstructure of the fusion line and the transitional zone between the HAZ and weld metal is fine-grained. The transitional zone between the heat affected zone and weld metal is shown on micrograph 2b). The structure of the weld metal is of dendrite pearlite - ferrite with acicular ferrite, micrograph 2c). Alloying elements Ni and Mo from cored wires were favorable for the formation of needle-acicular ferrite in the weld metal. Molybdenum influenced fragmentation of the primary structure of the weld metal and combined with Ni increased the amount of acicular ferrite. The presence of these elements prevented formation of upper bainite in the weld metal, while retaining the primary ferrite in weld metal base. This resulted in the increased yield stress with favorable toughness.

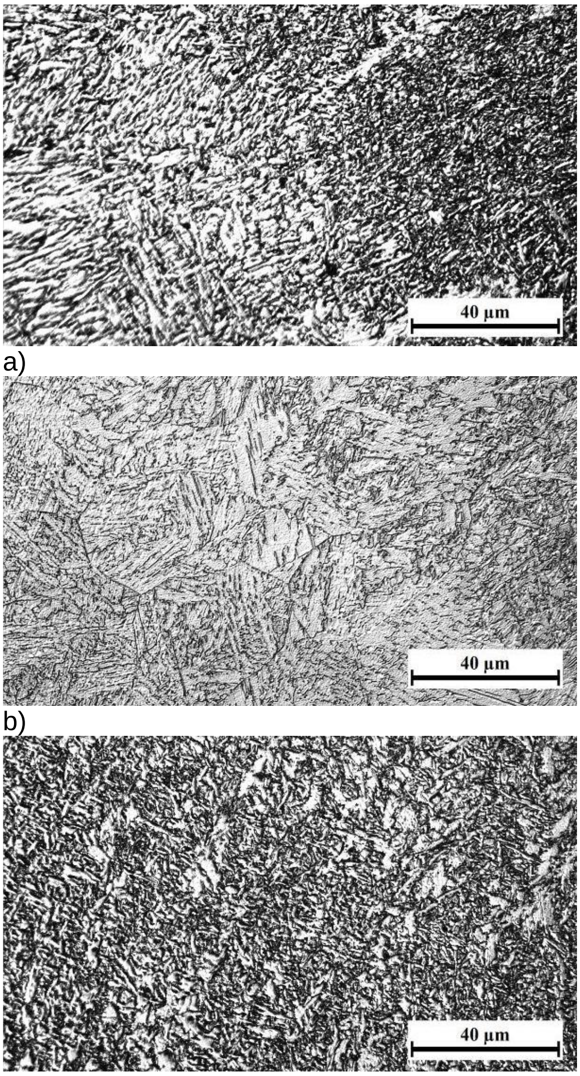

Figure 2. Microstructure of welded joint: a) fusion line, 500x; b) the transition zone between and weld metal, 500x and c) weld metal, 500x .

4. Conclusion

This paper presents an analysis of the influence of Ni and Mo in cored wires IHIS PŽ Ni2Mo and IHIS PŽ Ni1Mo on the mechanical properties and microstructure (WM) of welded joints of steel NIOMOL 490K. The analysis led to the following conclusions.

Testing of the chemical composition of weld metal has confirmed that the contents of Ni and Mo were in the set limits of the quality cored wire.

Ni content of over 1.5% in the weld metal influenced increase in yield stress and tensile strength. Mo content of 0.2 to 0.3% in the weld metal further influenced the fragmentation of the primary structure of the weld metal. Fracture toughness of the heat affected zone was higher than the fracture toughness of the weld metal. The impact energy consumed for all samples was quite uniform, indicating that in the WM and HAZ there were no local brittle zones present. The highest toughness values were achieved with cored wire IHIS PŽ Ni2Mo. The increased nickel content favorably affected the increase in toughness.

The microstructure of the base metal is a homogeneous fine-grained ferrite – pearlite. The microstructure of the HAZ is fine-grained ferrite - pearlite with spheroidized pearlite, which corresponds to the normalized structure of the HAZ. None of the samples showed presents of a brittle bainite phase in the HAZ. Along the fusion line and the HAZ no grain growth or presence of bainite were observed. The microstructure at the location of the fusion line and the transitional zone between the HAZ and weld metal is fine-grained. The structure of the WM is a dendrite pearlite ferrite with acicular ferrite. By using cored wire IHIS PŽ Ni2Mo for welding micro alloyed NIOMOL 490K, a good combination of mechanical properties and microstructure. The obtained results confirmed that with the new quality of cored wires good mechanical - structural properties, of welded joints of fine-grained steel NIOMOL 490K at room temperature, can be achieved.

Acknowledgements
The authors are grateful to the Ministry of Science and Technological Development for funding (TR 34 016, OI 174 004).

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THE EFFECT OF FIBRES ON FRACTURE BEHAVIOUR OF CEMENT-BASED COMPOSITE

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Abstract
The effect of fibres on fracture behavior of cement-based composites has been experimentally investigated. Different types (bent, flat and 'tin' steel fibers, and polypropylene fibres) and different amouts of fibres have been used, up to 2% of volume ratio. Experimental method based on crack growth by opening mode is used and results compared to the theoretical ones, indicating that fracture behaviour of cement based composite materials is predictable.

Keywords:
Cement-based composite materials, CTOD, fibres

1. Introduction
Building quality and efficiency is largely dependent on materials used. In order to improve the quality of building materials, tests have been performed with cement-based composites (CBC), which will be shown in this paper. Such composites have a matrix made of concrete and fibres of different types, amounts and sizes. For a detailed introduction to the behaviour of such materials it is necessary to determine the behaviour of their components. In this case, the components are concrete and fibres (bent, flat and 'tin' steel fibres, and polypropylene fibres with up to 2% of volume ratio) used as an alternative to reinforced and pre-stressed concrete.

Fibres in the cement-based composite materials improve the resistance to tension and pressure loading, as well as to bending, tearing and dynamic impact. Also, fibres contribute to prevention of brittle fracture. Fracture behaviour of CBC is greatly affected by the quantity, distribution, shape and size of fibres. Experience have shown that the increasing content of ribbed and hooked fibres is the best choice in terms of CBC resistances to crack growth, [1]. It has been also determined how cracks form and propagate in composite materials. Crack growth consists of four phases: linear, non-linear, stationary and final.

The experiment presented in this paper was based on both linear elastic and non-linear fracture mechanics parameters. The linear part includes the critical stress intensity factor, KIc, also called the fracture toughness. Its value is determined by standard means of applying quasi-static load on notched specimen up to a point where crack length causes an unstable crack growth.

The non-linear analysis is based on Barenblatt-Dugdale model and includes measuring of CTOD (crack-tip opening displacement) and CMOD (crack mouth opening displacement) to take into acount the plastic zone around the crack tip.

2. Cement-based fibre composites
This paper focuses on composites made of concrete and fibres. Concrete can take static pressure exceptionally well, but is weak against tension, bending, shear and dynamic impact. This is usually improved by adding reinforcing concrete with steel bars. Adding fibres (up to 5 cm long) to the cement-based matrix also increases its resistance to different types of load while also eliminating the downsides of classic reinforced or pre-stressed concrete.

The properties of such composites are affected by numerous factors such as the size, shape and distribution of fibres. Curved or hooked fibres have better properties since they result in better adhesion between the two materials, but are also more complex to make. Fibres within the matrix should be distributed evenly in order to ensure the best results. Adhesion can be further improved by increasing the radius of the fibres, but this can have negative effects on the fibre distribution. The choice of all these factors should increase the resistance to cracks, as well as tensile strength of the composite.

Adding fibres to the composites increases its toughness and the amount of energy it can absorb, making it more resistant to cracks. This is the result of combined effects from the matrix and the fibres in load transferring, causing the fracture to occur only after the bond between the two is broken, which is why a good connection between the elements of the composite is important. Such fracture is always ductile, except when poor fibre distribution is present in which case a brittle fracture occurs.

in this case there are two separate strengths that are being considered. The first one refers to the point at which the first crack appears, and corresponds to the loading - deflection diagram, and is mostly linear. The second strength corresponds to the maximum stress achieved. These are closely related to the amount, shape and type of fibres used. Smaller amounts of fibres result in maximum load being much closer to the load at which the cracks occur, because beyond that most of the load is received by the fibres.

3. Experimental results

The tests were performed using the so-called "pull-out" method, which is used to determine the force necessary to pull the fibres out of the composite. Results were obtained both visually and digitally.

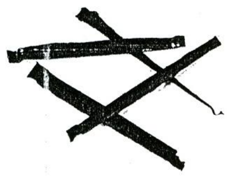
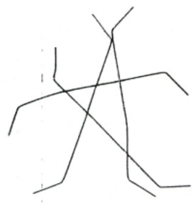
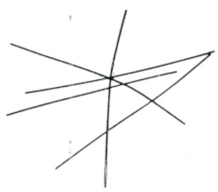
For these tests, 280 x 76 x 19 mm speci–mens were used, with fibre concentrations for 0-1,5% (concentrations close to 0% were insufficient where as larger ones, around 2% were too much) and fibre length of 25.4 mm. Four series of specimens were tested. The matrix consisted of prism shaped specimens, with 10x2x2 cm dimensions. The fibres were penetrated into the matrix up to the depth of 0.5, 1 and 1.5 cm. Types of fibres used are given in table 1.

Maximum “pull-out” force for steel fibres was obtained for type 2, which is almost identical to type 3, with the only difference between them being in the way they are anchored to the matrix. Hooked fibres have better adhesion and therefore show results which are up to 4 times better than type 3. Type 4 (polypropylene) gave better results than type 3, however these fibres have a noticeably larger radius, and were deformed significantly, unlike the steel ones.

Crack growth was analyzed based on force-CMOD diagrams obtained by three-point bending of a notched beam. CMOD consist of a linear elastic part (CMODe) and a non-linear part (which includes crack growth). These diagrams were used to determine KIc, using effective crack length (since determining the real length would have been to complex and expensive). Effective crack length represents the sum of initial crack length and effective crack elongation, where the latter is determined from the measured value of CMOD.

It was mentioned earlier that crack growth consists of four phases. During the first phase (linear), there is no difference between the strain states of regular and composite matrices. This phase is used for determining initial crack length. As crack length increases, its growth becomes non-linear, leading to the second phase. Experimental results have shown that non-linearity starts at approximately 10% crack length increase. At this point, tensile stresses starts being carried out by fibres. During the third, stationary phase, stress intensity factor reaches its critical value, resulting in stationary crack growth, and it is during this phase that the applied force reaches its maximum. This maximum value for cement-based matrices occurs later in comparison with regular ones, i.e. at greater crack lengths.

Table 1. Types of fibres used

	Type: 1 Steel “tin” fibres Length: 33 mm Manufacturer: “Metalski zavodi” Skopje, under German license
	Type: 2 Bent steel fibres Length: 45 mm, Radius: ϕ0,4 mm Manufacturer: “Milan Vidak” Futog, on author’s demand
	Type 3: Flat steel fibres Length: 45 mm, Radius: ϕ0,4 mm Manufacturer: “Milan Vidak” Futog, on author’s demand
	Type: 4 Polypropylene fibres Length: 30 mm Manufacturer: Unknown. Used by GIK “1. Maj”, from Backa Topola

Forth phase includes fracture, completely separating the components of the matrix, which means it is no longer a composite and therefore is not the subject of this research.

An example of the force-CMOD diagram is given in Figure 1 obtained experimentally and theoretically (based on pull-out force, as explained in [1]). This is just one of the diagrams that were obtained for all four specimen types.

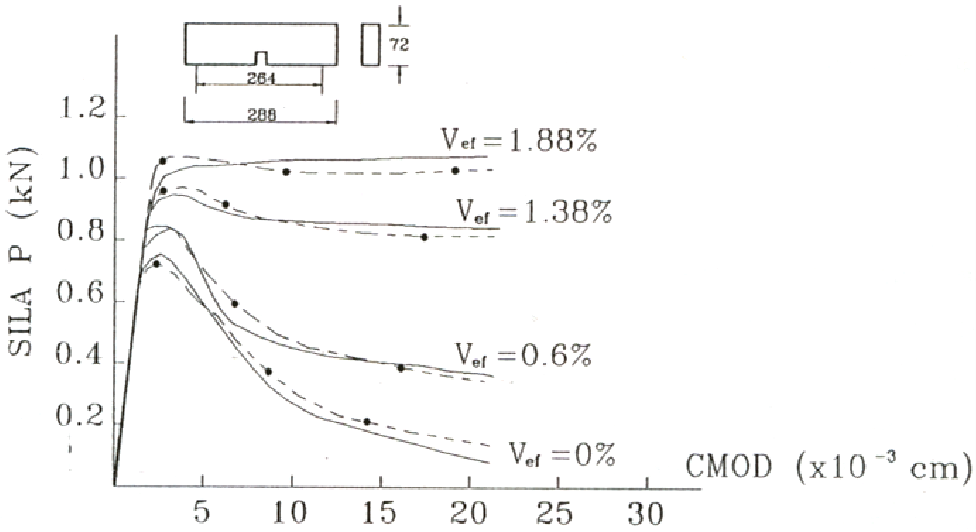


Figure 1. Comparison of theoretical and experimental results in a force-CMOD diagram

The diagram above represents the effective volume, which was used in order to include the effect of fibre distribution as well. We can see that theoretical and experimental values are very close to each other, and at some points in the diagram, equal. As V_{ef} increases, the difference between the maximum values of theoretical and real results also slightly increases, which suggests that there are limitations to this method of testing. As an illustration, crack developed in a sample, is shown in Figure 2.

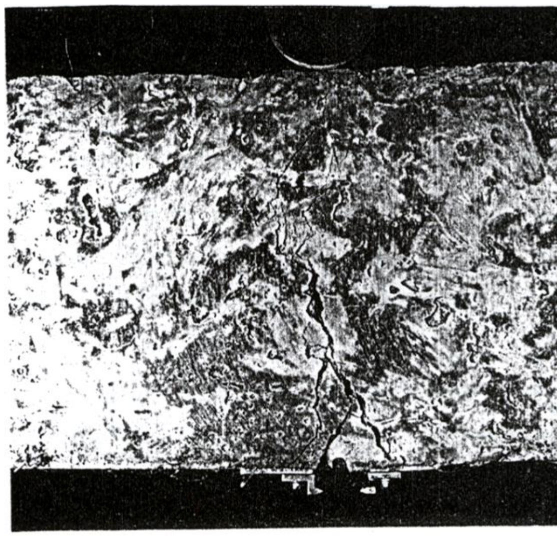


Figure 2. Crack growth through the composite

4. Conclusions

Results obtained by these tests show excellent agreement with theoretical values. This suggests that it is possible to predict fracture behaviour of fibre composite materials, assuming one knows how cracks grow and force required to pull fibres out of composite.

It was also determined that addition of fibres to a cement-based matrix significantly improves resistance to crack growth, and that this is greatly affected by the distribution, size and shape of fibres. All of these factors are closely related and it is often required to find a compromise between them to ensure best composite properties.

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MECHANICAL ASPECTS OF HORIZONTAL VESSELS ON SADDLES

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Abstract
Horizontal cylindrical tanks are provided in range of size to store liquid products. These consist of a circular cross-section cylinder generally of constant wall thickness with hemispherical ends. The supports may be saddles as shown in Figure 1. The horizontal vessel supported on two saddles as a simply supported beam. The distribution of the interface forces in the saddle areas is very complex.
Approximate analysis using beam and ring behaviour is used for design of vessels. Aims of this paper is to show the approximate analysis and give computer solution with FEM.

Keywords:
Storage structures, cylindrical, shell, FEM

1. Introduction

If storing liquid products in tanks with the volume less then 500 m3. The horizontal vessels have more advantages in comparison with upright tanks. These advantages are the following:

- the tanks can be fabricated in workshop due to their smaller dimensions
- the evaporation loss of the stored liquid is reduced
- it is convenient for storing liquid under pressure
- the technical condition of the tank can be easily tested.

The horisontal vessel supported with two saddles is statically advantageous. Sometimes it is a good solution to use more saddles to reduce the saddle reaction. The contact angle at the saddles should be minimum $\Theta = 120^0$ according to the ASME code.
The maximum diameter of the vessel is
D = 4 m for fabrication reasons.
It is mathematically verified that a cylinder with a give volume has a minimum surface if L=D. The smaller surface also decrease the fabrication cost.

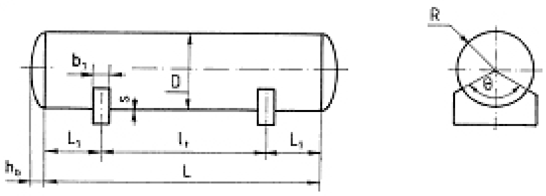

Figure 1. The horizontal vessel supported on two saddles.

2. Methods

In generally we design the vessel for full water load.The load of the vessel is inner pressure, which in many cases comes from hydrostatic pressure. The vessel has additional wind loading, here this will be neglected. The standards t.e.x BS 5500 and Hungarian Standard use approximate analysis.
The supports are located away from the ends. We should ensure the some bending moment the mid span and the supports ($L_1 \approx 0{,}207L$).
The beam approximations are shown in
Figure 2.

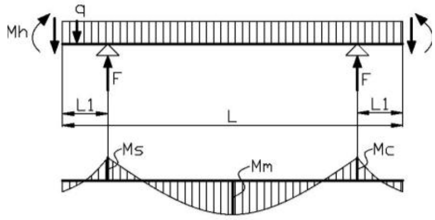

Figure 2. Loads of the beam and moment diagram.
The distributed load is q.

$$q = \frac{2F}{L + \frac{4 \cdot h}{3}} \tag{1}$$

The moments at end of the beam thank to the hydrostatic pressure:

$$M_h = \frac{qR^2}{4} \tag{2}$$

The shear force T in the plane of saddle, the bending moment M_s at the saddle and the mid-span bending moment M_M.

$$T = \frac{F(L - 2L_1 - h)}{L + h} \tag{3}$$

$$M_s = F \cdot L_1 \left[1 - \frac{1 - \frac{L_1}{L} + \frac{R^2 - h^2}{2L_1 \cdot L}}{1 + \frac{4h}{3L}} \right] \tag{4}$$

$$M_M = \frac{FL}{4}\left[\frac{1+\frac{2(R^2-h^2)}{L^2}}{1+\frac{4h}{3L}} - \frac{4L_1}{L}\right] \quad (5)$$

The longitudinal bending stresses are calculated as follows. At mid span the entire cross-section is effective:

$$\sigma_b = \frac{M_M}{\pi \cdot R^2 \cdot t} \quad (6)$$

t – thickness of shell.
Buckling is possible in both partially filled and completely full vessels [1]
It has been found that when R/t is high, large vessel displacement occur while filling. As the vessel is progressively filled the cross-section rounds up due to the hydrostatic pressure of the liquid on vessel walls.
When completely full, the displacements are relatively small.
It has been found that in vessels with R/t in the range of 100 to 600 buckling can occur when the vessel is 70 % full when L/R is less then 10.
However in vessels with L/R greater than 15, buckling will occur only when the vessel completely full. In order to prevent both evantualities, the compressive stress when the vessel is completely full is limited to an allowable stress given by equation (13).

$$\sigma_c = 0.625\frac{E \cdot t}{R}$$

To examine region of saddle it must be assumed ring (arch) behavor. It is also necessary to use a ring stiffener.
The saddle reaction F causes tangetial shear forces in the shell cross-section in the plane of the saddle in Figure 3.

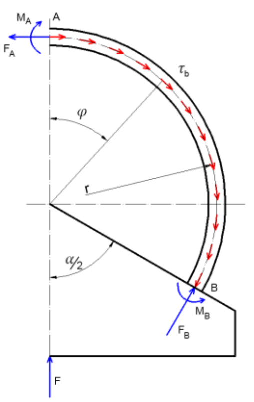

Figure 3. The fixed arch subjected to shear stress

The shearing stress originates from tangential bending moments.

$$\tau_s = \frac{F \cdot \sin\varphi}{r \cdot \pi \cdot t} \quad (7)$$

The stiffener cross-section is cheked for the compressive forces F_A , F_B and bending moments M_A , M_B.
F_A , M_A can be determined, if we cut the arch at the cross-section „A" and prescribe displacement u_{xA} = 0 and rotation φ_A = 0. Loading from the shearing stress.

$$M_\alpha = \frac{F \cdot r}{\pi}\int_0^\alpha [\sin\varphi - \sin\varphi\cos(\alpha-\varphi)]d\varphi = \frac{Fr}{\pi}\left(1-\cos\alpha - \frac{1}{2}\alpha\sin\alpha\right) \quad (8)$$

The stiffener cross – section shown at Figure 4.

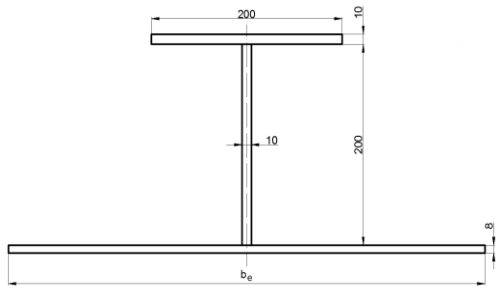

Figure 4. Cross-sectional area of arch.

The effective width b_e.

$$b_e = a + 4 \cdot \sqrt{D \cdot t} \quad (9)$$

3. FEM analysis
The FEM analysis was executed by COSMOSM 2.8. The type of element is SHELL.
For using the symmetry of the structure it is enough to examine the quarter of the vessel. Figure 5.

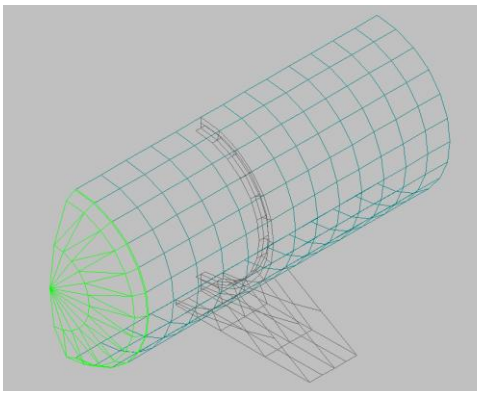

Figure 5. Finite element mesh.

Loads of the vessel are hydrostatic pressure and dead load.

4. Numerical example

The given data are volume V = 100 m^3, length of the cylindrical part L = 13000 mm,
L_1 = 2690 mm, the thichness of wall of cylindrical part t = 6 mm.
The dimensions of stiffener can be seen on Figure 4.

5. Results

At first we try to compare the results of beam modell and more realistic FEM modell.
Secondly the region of saddles is examined.
The longitudinal bending stress at the lower point of the cross section of the saddle.

$$\sigma = \frac{p \cdot R}{2 \cdot t} + \frac{M_m}{R^2 \pi \cdot t} = 9{,}35\ N / mm^2 \qquad (10)$$

p is the average value of hydrostatic pressure
According to FEM analysis σ = 8,15 N/mm^2
Deviation between two values is exeptable.
The circumferential bending stresses at the cross-section "A" (Figure 3 and Figure 4).
Stress at the T stiffener

$$\sigma^{+}_{MAX} = \frac{F_A}{A} + \frac{M_A}{I} e_2 = 37\ N / mm^2 \qquad (11)$$

$$\sigma^{-}_{MAX} = \frac{F_A}{A} - \frac{M_A}{I} e_1 = -9{,}55\ N / mm^2 \qquad (12)$$

e_1, e_2 – distanced of the centroidal axis.

Table 1 Results of stresses at the cross-section A in MPa.

Methods	Upper point	Lower point
Simplified modell	-9,55	37
COSMOS/Geostar	-6,9	38
Designstar	-16,6	45,78

The results agree each other.
The loading at the simplified modell is bending thanks to shearing stress. At the Geostar modell the loading is hysrostatic pressure (Figure 6).
At the Designstar modell the loading is uniformly distributed vertical forces.
The deformation of the vessel was examined. The biggest vertical displacement at the saddle region is 0,78 mm, which is very small.

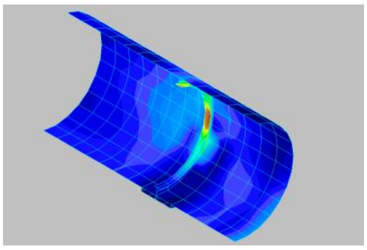

Figure 6. Stresses near the stiffener ring

6. Conclusion

The aim of this study is compare different methods. The approximate analysis uses beam and ring behaviour.
The British and Hungarian standards use this approximated method. The FEM analysis meke it possible to examine the problem more accurately.
The results from different methods are at good agree.
In this example the saddle reaction causes bigger stresses.

7. References

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THE ERGONOMIC ASPECTS OF WORK WITH CHAIN SAWS

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Abstract
Work with a chain saw includes many different working situations requiring simple as well as more difficult procedures. For obtaining more exact knowledge about negative vibrations values acting on hands of operators there is necessary a long term research of the problem for individual types of chain saws by producers like Husquarna, Stihl, etc. It is necessary to consider different designs of chain saws.

Keywords:
Ergonomic aspects, Chain saws, noise, vibrations

1. Introduction

At the present time the tree felling and delimbing are realised during the whole year and the high standards are given onto a working tool. Chain saws are modified to the conditions of professionals as well as private users by a progressive construction, powerful engines and an accurate weight. These conditions make them comfortable, not difficult for operation, safety, with components harmless to the environment. Cold conditions, moisture and vibrations are the most common source of problems for forest workers using a chain saw. Work with a chain saw includes many different working situations requiring simple as well as more difficult procedures.

2. Vibrations of chain saws

According to the valid standards for vibrations measurement on chain saws (ISO 5349-1:2001, STN ISO 7505, STN ISO 22 867) there are used measured frequency evaluated accelerations on the holders of a chain saw. The evaluation of exposition range is realised on the basis of calculations of a day loading by vibrations standardised on the frequency value of 8 hours. Regarding to initiating and limit values for exposition it is necessary to realise the measurement and following actions according to the guideline 2002/44/EC. The initiating values have preventive character with a goal to eliminate the occupational diseases caused by vibrations.

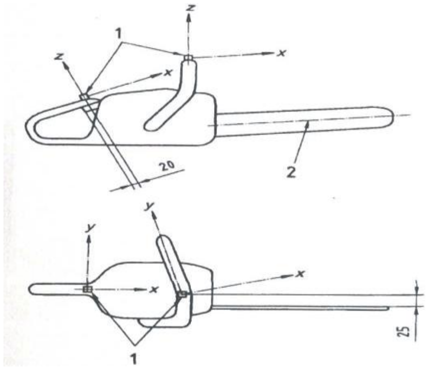

Fig. 1 The position of sensors during measurement of vibrations

If an operator of a chain saw exceeds the limit value for exposition A(8) = 5 m.s-2, it is possible to expect significantly higher risk of an occupational disease caused by vibrations. Individual detecting, evaluating and analysis for certain people, is the goal of risk assessment when the operator of a chain saw is exposed to daily loading by vibrations A (8) which exceed initiating value 2,5 m.s-2. For detecting daily loading by vibrations A (8) there are used weighted total values of vibrations ahv which put together all three ways (x,y,z) of vibrations acting on every holder of a chain saw (Fig. 1).

3. Noise of chain saws

Measurement of noise and vibrations on chain saws shall be realised on the basis of requirements according to STN EN ISO 22 868 – the testing guideline for measurement of noise (Fig. 2). The evaluation of measured noise consists of calculating for established units and comparison with a valid legislation. At the present time, within the area of the Slovak Republic there has been valid the Government Regulation of the Slovak Republic Act No. 339/2009Coll. which establishes conditions about allowable limits of noise, infrasound, vibrations and vibrations objectivity. This government regulation establishes requirements for health protection against risk caused by noise and vibrations exposition and this risk prevention.

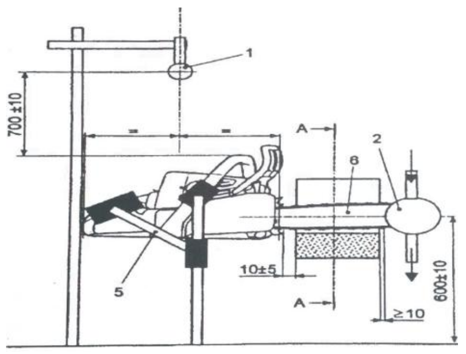

Fig. 2 The measurement of acoustic pressure at the place of operation

After realisation of the measurement according to STN ISO 22 868 and STN ISO 9207 there is calculated the level of an acoustic performance which is given as follows:

LW = LP + 10log S [dB]

where: LP is the level of an acoustic pressure on the surrounding measurement surface

S is the measurement surface in m2.

It is possible to define a loading noise by measuring levels of an acoustic noise, evaluating spectrum and defining levels of an acoustic performance at the chain saws. In this case the limit value of the acoustic loading is 85 dB which is given by the mentioned government regulation and the standards. After the limit value exceeding there are necessary such preventions which eliminate negative values of noise and thus protect health of workers.

4.Conclusion

For obtaining more exact knowledge about negative vibrations values acting on hands of operators there is necessary a long term research of the problem for individual types of chain saws by producers like Husquarna, Stihl, etc. It is necessary to consider different designs of chain saws. Noise and vibrations produced by a chain saw negatively affects the whole body of an operator. There is necessary to use ear protection and the best choice for operators is to use ear protection in combination with a helmet. According to the present knowledge of working with chain saws it is known that working with it is risky and it has negative impact on health of operators. This is the reason why the most famous producers established different technical support to decrease vibrations and noise. It is necessary to realise several actions within the maintenance of chain saws to obtain the goal of technical support.

5. Acknowledgement

This poster was created during the processing of the project VEGA MŠ SR n.1/0403/11 The Chain Saws research of Technical Parameters regarding to Ergonomics and Ecology Work.

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CONTRIBUTION TO THE USER REQUESTS MANAGEMENT BASED ON ITIL IMPLEMENTATION

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Abstract

Implementing the best practice in IT services organization could be done with support of the of the third party solutions (i.e. CA tools). However, these tools do require significant investments and continuous specialized support. In cost / benefit analysis for small to medium sized companies it might be hard to justify these expenses.

In this paper the emphases is given to the modeling of the Services desk solution that could be implemented using existing tools that company already posses (i.e. e-mail system, office tools, document management system, etc.).

Keywords:
ITIL, Service Desk, Model, IT, User Request, System, Management

1. Introduction

ITIL (Information Technology Infrastructure Library), was published between 1989 and 1995 in Great Britain on demand of british government agency [1] and in the name of Central Communication and Telecommunication Agency (CCTA).

Initial goal was to create conditions needed for IT market regulation. Many IT sistems had not been functioning as they were supposed to, so that was one of the reasons why companies could not provide quality of their services on time.

That is the reason why it is so important to develop methods for IT services management. ITIL service management covers the whole life cycle, starting from original idea or request, through planning strategy and design, use, improvements over time and final withdrawal of the service. It covers process service management as well [4].

The main ITIL roles are:

- ***Customer*** – client, customer; company that finances service,
- ***Provider*** – service provider; company that provides service,
- ***Supplier*** – company that delivers hardware / software and
- ***User*** – person who uses service.

2. Method

IT library infrastructure was developed as a book collection, where each book covered certain usage of IT services management [2]. ITIL was built as a process model based on control and management of work and very often is associated with Deming model, PDCA (plan-do-check-act, PDCA) shown in Figure 1.

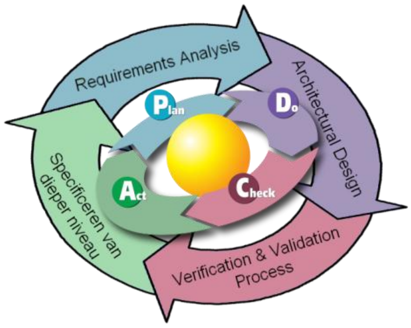

Figure 1. Deming model

V2 publication was created as a version for „best practice“. First set, which contains 31 books, was shrunk to the set of 7 books which fully covered IT service management.

IT service management processes could be divided into two groups:

- Service Support [5] and
- Service Delivery [6]

Service delivery is focused on future changes through:

- Service level management,
- Financial management,
- Capacity management,
- IT service continuity management and
- Availability management.

Support service is oriented on daily operations and tasks, including:

- Incident management,
- Problem management,
- Changes management,
- Configuration management and
- Edition management.

Service Desk represents first line of IT users support. If employee in Service Desk cannot solve an incident, he transfers it to IT specialists who represent second line of IT support.

Third line of support consists of suppliers who delivered software / hardware.

Key performance indicator for Service desk

It is important to use even range of metrics for Service Desk effectivity measurements. Typical metrics include [3]:

- Service Desk calls number,
- Calls number to the rest of support staff (number of escalations should decrease during time),
- Shortest call time,
- Clients satisfaction (questionnaires) and
- Help usage (if exists).

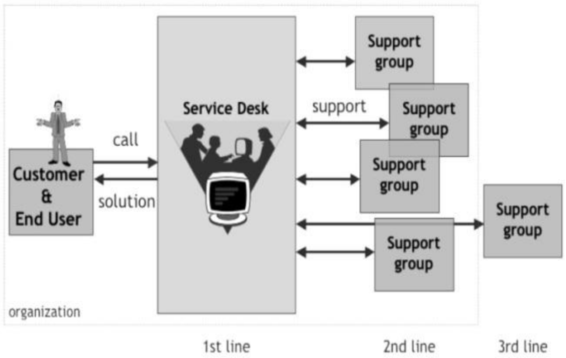

Figure 2. Service Desk manages all final users

IT service life cycle is a basic concept of ITIL V3, as well as full view which includes whole life cycle of the service. It answers on the questions how and why [3]:

- Why customer needs a service?
- Why would customer buy a service from us?
- Why would we provide different availabilities, capacities and continuities?

Asking a service provider these questions enables defining general strategic plans for IT organization, which will be used to conduct services during their design, transition, support and improvements so the maximum value would be delivered to clients and stakeholders.

3. Modelling user requests management system

To represent functions and roles in discussed system for dealing with user requests it is first needed to realize a case diagram. Diagram is shown in Figure 3.

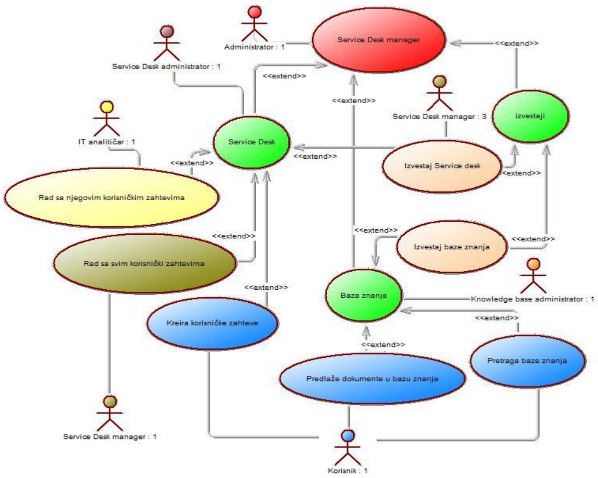

Figure 3. Using cases

In this system it is needed to define a hierarchy of rights for the system use, shown in Figure 4.

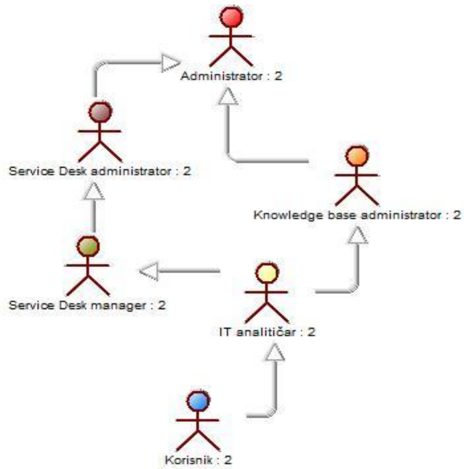

Figure 4. Hierarchy of using rights for *Service Desk Manager*

An example of model functioning is shown in the Table 1. and Table 2.

Table 1. An example of model functioning

Use case	Creating user request
Short description	If problem occurs, user creates request
Participants	User
Conditions needed before execution	System sign in
Description	User fills personal information and information about problem
Exceptions	[No problem description] requires entering problem description
Conditions needed after execution	Request is saved in a Service Desk application base as un adopted

Table 2. An example of model functioning

Use cases	Working with all user requests
Short description	Accepting and forwarding user requests to IT analysts
Participants	Service Desk administrator
Conditions needed before execution	System sign in
Description	Accept request, process it and submit it
Exceptions	
Conditions needed after execution	Request submitted

There are the same procedures for every user request submission. Activity diagram of dealing with user request is shown in the Figure 5. and Figure 6.

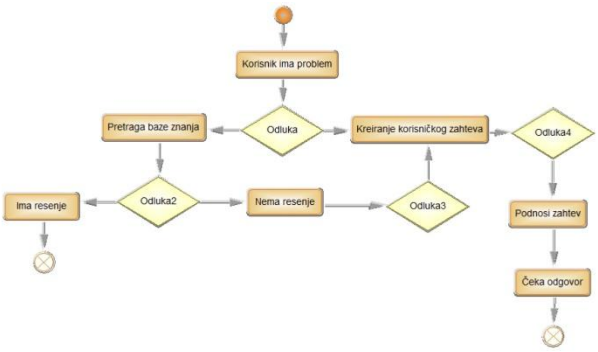

Figure 5. Activity diagram for user request submission

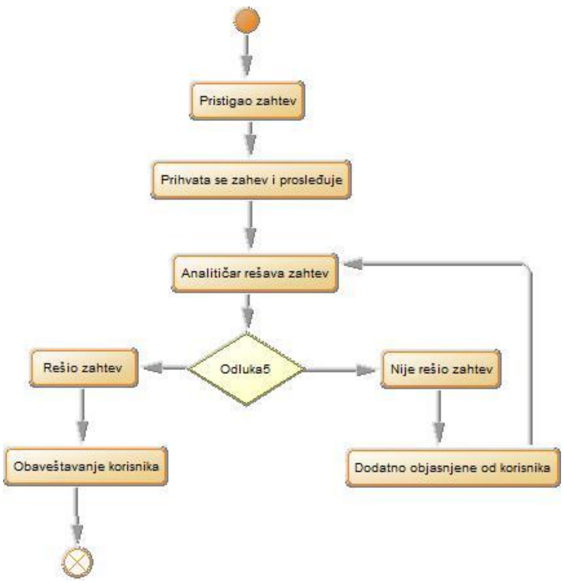

Figure 6. Activity diagram for dealing with user request

4. Example of dealing with user request

In the system for solving users requests there can be used different tools which meet the need of ITIL:

- Specialized tools and
- Combination of tools - e mail, office tools and dms.

Case 1 shows when IT service user has a problem with infected computer using the both tools.

Case 1.
IT service user has a problem with infected computer. He should immediately disconnect computer from network and contact Service Desk department. Service Desk instructs user to create a user request (from another computer) as it is shown in the Figure 7.

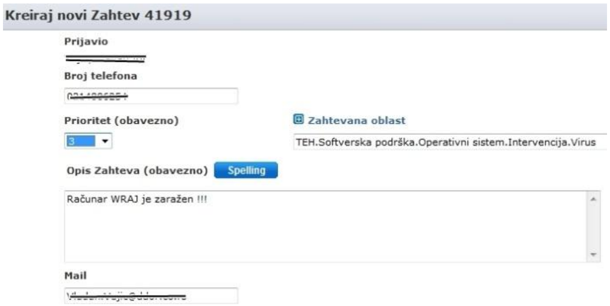

Figure 7. Creating a new user request

Service Desk analyst sees unallocated requests and opens it by clicking a request number.
He checks weather the request is correct and after that allocates it to a responsible analyst for solving. Analyst who is given the request, starts solving the problem, as it is shown in the Figure 8.

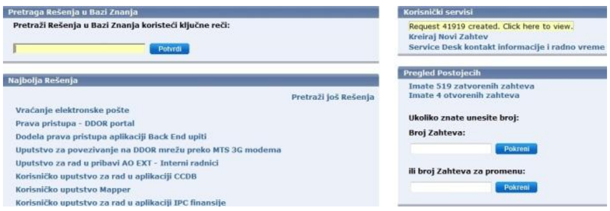

Figure 8. Request created

Case 2.
In the Case 2 which is combination of MS Office and DMS tool, user creates request using MS Word tool, which starts as a Template from the public folder of the e-mail (MS Outlook). Template is located on the Exchange server. After filling the template request, user sends e-mail (with filled Template in attachment) to Service Desk address. Service Desk analyser accepts request on the way he opens e-mail, checks if the request is filled correctly, indexes it and connects user request with DMS system and submits it to Service desk

analyser for solving. As all requests are sent to DMS base, all conditions are created in DMS base, and the conditions for following, solving and reporting are created with user requests for solving IT problems. In both cases the procedure of sending and solving request is identical and the only differences are tools which are used. In both cases ITIL standard V3 is fully satisfied.

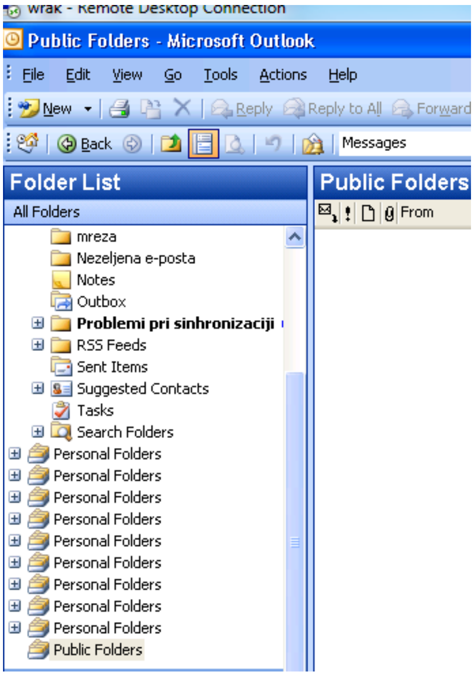

Figure 9. Taking over the user request

Figure 10. User request

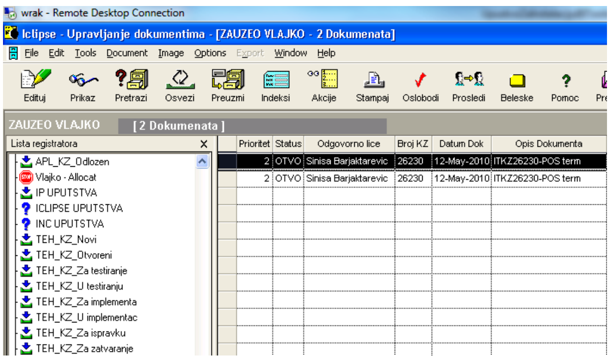

Figure 11. Dms tool for indexing request

5. Conclusion

In this work there are analysed abilities and demands of clients using technics provided by Service Desk operation. An example how to model system independently from used tool is given. A user request case study is given as well as answer to their solution using ITIL V3 methodology. Service Desk is a solution that enables simple, quality and reliable service and support of IT services to users.

This is achieved using different technologies integrated in a single solution which enables:

- Unique user access point,
- Simpler process management for IT managers, record of maintenance costs and problem resolving,
- Eliminating bottlenecks due to uneven work share and
- More precise evaluation of work done by IT analysts.

The main lack of the system is a problem of reliability the information obtained from the processing of textual comments about product quality and services which are created by users. Regardless of numerous investigations in this area there are still many problems, so in the future there should be paid more attention to this problem.

6. Acknowledgement

Research for this article was conducted under the project "Development of software to manage repair and installation of brake systems for rail vehicles", Ministry of Science of Serbia, no. 035050, for the period 2011th-2014th year.

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EDUCATION SECTION

ARE RURAL ELDERLY PEOPLE LESS PHYSICAL ACTIVE THAN THOSE LIVING IN URBAN AREAS?

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Abstract
The aim of this study was to compare and examine the functional status between urban and rural community-dwelling elderly people. Four hundred ninty five subjects (mean age: 67.84±6.56 years, body height: 170.27±10.07 cm; body weight: 75.31±13.16 kg) were included in this study, 168 were from rural area (34%) and 327 from urban area (66%). To determine the trend of changes of anthropometric parameters and physical fitness in people aged over 60, we used Senior Fitness Test (SFT) and basic morphological parameters. There was statistically significant difference ($p<0.05$) between subjects of urban (-6.96±10.02 cm) and rural (-11.55±10.49 cm) area in parameters of flexibility. Respondents are most different in terms of strength in upper extremities. Better results were observed in rural subjects then in urban (16.32±6.57 vs. 15.21±5.29 repetitions). From the demographic data, we were able to see that the composition of the urban and rural population is not much different.

Keywords:
older people, senior fitness test, geographic region, urban area

1. Introduction

Rapidly increased number of elderly people represents a demographic characteristic of modern life around the world. Anthropometric and nutritional characteristics are related to genetic, environmental, sociocultural conditions and to lifestyle, health and functional status [1]. Several cross-cultural studies show that there are significant statistical differences in body composition and physical fitness among different ethnic groups of people while the difference was much smaller when it comes to aged-related inter-population, where the homogeneity of a large group is more obvious [2], [3], [4], [5].
Body composition and physical fitness in elderly people could be influenced by the genetic potential, early growth and development, differences in socio-economic status, health status, as well as by geographic region and ethnic group affiliation [6]. Increased self-care and mobility are associated with a greater degree of independence and a higher quality of life. [7] claimed that measuring physical function with either performance-based or self-report is complex, as both methods determine different aspects of function.
A large number of risk factors influence the functional status of elderly persons, regardless of gender. Some of them are age, level of cognitive function and depression. One factor that might also affect functional status among elderly people is geographical difference. Unfortunately, few data are available to document differences between elder people living in rural and urban areas.
Studies [8] show a statistically significant difference in the level of health status among elderly urban and rural areas. These differences are particularly pronounced in developed countries. This difference is primarily reflected in the difficulties the elderly access to rural areas of health care. In the USA, some studies examined PA differences between rural and urban adults [9], [10], [11] and results consistently showed that rural adults were less physically active than urban adults.
The Behavioral Risk Factor Surveillance (BRFFS) data on leisure time physica activity in 49 states indicated that physica inactivity was higher in rural than metropolitan areas. Urban-rural comparisons remain limited in their ability to identify what factors influence the health behavior decisions, including the decision to be physically active or not. Features in urban and rural areas change over time and some factors may change due to population migration.
The aim of this study was to compare and examine the functional status between urban and rural community-dwelling elderly people.

2. Methods

Four hundred ninty five subjects (mean age: 67.84±6.56 years) were included in this study, 168 were from rural area (34%) and 327 from urban area (66%). General descriptive parameters of the respondents are shown in Table 1. The age of respondents ranged from 60-91 years. Participation in the study was voluntary and all respondents were able to withdraw at any time of testing. The study was approved by the Ethical Commission of the Faculty of Sport and Physical

Education, University of Nis, in accordance with the Declaration of Helsinki. All subjects were first informed about the possible consequences of testing as well as the benefits that this research brings to their age population. Testing of all subjects was between October and December 2011. All subjects were mentally and physically able to participate in the study.

Table 1. General descriptive parameters

	Rural area *n*=168	**Urban area** *n*=327	**Total** *n*=495
Age (years)	68.63±6.69	67.44±6.46	67.84±6.56
Body height (cm)	169.45±10.99	170.69±9.55	170.27±10.07
Body weight (kg)	74.61±14.14	75.67±12.65	75.31±13.16

To determine the trend of changes of anthropometric parameters and physical fitness in people aged over 60, we were divided subjects in 5 age groups: 60-64, 65-69, 70-74, 75-79 and over 80 years of age. Their basic descriptive characteristics are given in Table 1. Trained persons for the purpose of this study were first performed a standard interview with a potential respondents individually or in small groups at their homes or in the active center for the elderly. Each of the respondents were first given their demographic characteristics and then joined the determination of anthropometric measures and the Senior Fitness Test (SFT).
Anthropometric measures, measured in accordance with the recommendations of the International Biological Program - IBP. The height of the body is measured with a measuring tape, 0.1 cm accuracy.
Senior Fitness Test is a battery of tests for assessment functional fitness of older persons. This test evaluates the physiological capacity to perform normal daily activities independently and safely without the appearance of fatigue. Prior to execution of the test subjects first well as doing 10-min warming up led by a trained person, and then perform a complete SFT in the order of tasks referred in this test [12]. This test was validated by [13]. The test consists of six measures of physical fitness: 1) the mobility of the shoulder, 2) bent on a chair, 3) eight feet, 4) rising from a chair for 30 seconds, 4) flexion of the elbow joint, 5) two-minute step test. The mobility of the shoulder estimated flexibility of the upper extremities. Each subject performed two test attempts and two attempts which is measured and included in further analysis. The result is the shortest distance between extend middle finger of both hands. Bent on a stool test that evaluates the flexibility of the lower extremities. As with the previous test, each participant performed two test trials and two attempts, which is measured and included in further analysis. The result represents the maximum distance between extend finger tips and toes. Test 8 feet estimated agility and dynamic balance. Each of the subjects performed a pilot trial and two which is measured and later analyzed. The result is the shortest time achieved from the moment of getting up from his chair, traveled eight feet, turn and return to sitting position. Rising from a chair is a test that evaluates the strength of the lower extremities. Each subject has two test and then attempt to access the measurement protocol, which means getting the maximum number that can be brought to the respondent for 30 seconds. Test flexion at the elbow joint estimated the strength of the upper extremities. Each of the respondents first made two test attempts and then completes the test in 30 seconds. As a result of the calculated total number of reps with the entire range of motion performed in 30 seconds. Two-minute step test is a test that evaluates muscular endurance. Respondent faces the wall should do the maximum number of steps to the given height in two minutes. The test is performed only once a respondent during this test does not run but walk as quickly as possible.
The collected data were analyzed using statistical software SPSS 17.0 (SPSS Inc., Chicago, IL). Descriptive statistical parameters were calculated for every variables. To determine differences in anthropometric, fitness, and functional parameters we were used Univariatie analysis of variance (ANOVA). Statistical significance was $p<0.05$.

3. Results

The largest number of subjects was in the group of urban then in rural areas. A statistically significant difference ($p<0.05$) was not observed in body weight between subjects from differnt geographycal areas. No significant differences were found in all weight height relations between people older than 60 years.
In Table 2 we see that when it comes to flexibility (back scratch), there is statistically significant difference between respondents of urban (-6.96±10.02 cm) and rural (-11.55±10.49 cm) area. The parameters for the assessment of agility and dynamic balance (eight feet test), there is no statistical difference between groups. Respondents are most different in terms of strength in upper extremities. Better results were observed in rural subjects then in urban (16.32±6.57 vs 15.21±5.29 repetitions). This results are statisticaly significatn ($p<0.05$).

Table 2. Differences between urban and rural areas

	Rural area *n*=168	Urban area *n*=327	Total *n*=495
Back scratch (cm)	-11.55±10.49*	-6.96±10.02*	-8.52±10.40
Chair sit and reach (cm)	.31±10.18	1.50±8.23	1.09±8.94
8 foot up and go (sec)	7.964±3.524	8.75±5.74	8.484±5.10
Chair stand in 30 seconds (sec)	13.88±6.30	13.38±4.97	13.55±5.40
Arm curl (repetitions)	16.32±6.57*	15.21±5.29*	15.58±5.77
Two minutes step test (repetitions)	63.12±47.06	65.09±37.49	64.41±41.03

*- statisticaly significant differences ($p<0.05$)

4. Discussion

For elederly people in this study, there was no differences in many variables (chair sit and reach, 8 foot up and go, chair stand in 30 seconds and two minutes step test). Although urban people were significantly less socerd in upper arm strength test but better in flexibility test. Our findings are very similar to the results of previous studies. In Europe, almost no studies have examined the differences in physical activities between rural and urban adults until now [14]. Only one study in older Icelanders could be identified, showing no significant differences in physical activities [15]. Generally, the findings showed that urban individuals were not better in physical fitness parameters rural participants.

From the demographic data, we were able to see that the composition of the urban and rural population is not much different. One reason is the fact that these are older respondents who were both inactive. Therefore, their place of residence is not an important factor when it comes to their functional and motor skills. Another reason is the lack of information when it comes to the benefits of physical activity, so that only a small number of respondents involved in some sort of physical activity.

Limitations in this stady were no Geographic Information Systems database which used to collect objective data on the physical environmental attributes in the different areas. Rural and urban areas are not completely homogenous so the results may not always be widely applied. Another limitation to this is study is the cross-section design. The information is based on a one time collection of data and does not provide a look into the future or past physical activity levels of these elderly Serbian people.

Living in an urban setting was independently associated with higher functional performance [8]. No significant geographycal differences suggest that other enivronmental factors may play relevant roles. Because functional status is critical to the health outcomes of older persons and their families, functional ability and its management are an important public health problem. Knowing the different and common factors that affect functional status is important not only for the deployment of secondary and tertiary prevention, but also indicates effective treatment approach for rehabilitation, particularly among the elderly living in different environments.

5. Acknowledgement

This research was carried out as part of the project financed by the Ministry of Science of the Republic of Serbia, entitled “Physical activity and the fitness component of the elderly“ (number 179056), approved in 2010, and which is being carried out by the Faculty of Sports and Physical Education of the University of Niš.

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DIFFERENCES IN BODY COMPOSITION AND PHYSICAL FITNESS IN ELDERLY MEN AND WOMEN

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Abstract
The aim of this study was to determine differences in body composition and physical fitness in elderly men and women. Five hundred twenty six subjects were included in this study, 272 were men (52%) and 254 women (48%). To determine the trend of changes of anthropometric parameters and physical fitness in people aged over 60, we were divided subjects in 5 age groups: 60-64, 65-69, 70-74, 75-79 and over 80 years of age. Decrease in strength is observed with the aging process so that the respondents aged 60-64 years significantly differ in the strength of the lower extremities of elderly subjects 70-74 and 75-79 years of age. Also this difference is noticeable if we compare men and women. In this study, we found that there was an increase in the amount of adipose tissue, reducing the level of muscle activity and decreased muscle strength and endurance of the aging process.

Keywords:
older people, functional fitness, reduction, body mass index

1. Introduction

Anthropometric characteristics and functional fitness are closely linked to lifestyle, health and functional status of elderly persons [1]. It is therefore very difficult to give a standard interpretation of their values. Process of aging brings with it a number of physiological and nutritional changes such as decreased body mass and body height [2]. It is well known that excessive body weight and obesity are closely associated with increased risk of cardiovascular disease, then hornicnih disease and reduced function of the mobility of the body [3]. Both body mass index and circular dimensionality of the body regions in waist, abdomen and hips can be used as a good indicator of obesity people over 60 years of age [4].

It has been established that male persons who have waist over 94 cm are at increased risk, and over 102 cm greatly increased risk of comorbidity, notably those on the cardiovascular system [2]. Women with waist circumference over 80 cm recorded at increased risk, and over 88 cm greatly increased risk of developing these complications [5]. Longitudinal studies [6] shows that the body mass decreases in the elderly men and women after 60 years of age. Body weight is significantly different between men and women (70.3 vs 62.7 kg) and height (163 vs 152 cm) according to a study Sanchez-Garcia et al., 2007, which was confirmed by other studies [7]. It is believed that 75 years is a milestone in terms of BMI, and anthropometric measures in men and women.

During a life relationship between fat and lean body constantly changing. According to Mišigoj-Durakovic, (1999) maximum ratio of lean to fat is reached about 20 years, to then decline in the ratio of physically inactive people. After 20th years is expected normally increase fatty part of the decade to 60 years of age. After 60th years total body mass starts to decline.

Notwithstanding these anthropometric changes, the level of functional fitness is often used as a parameter for monitoring and assessing population health and almost always associated with health status. It can be defined as the physical capacity to perform daily activities independently and without any appearance of fatigue, which includes components such as muscular strength and flexibility of the lower and upper extremities, aerobic endurance and motor agility / dynamic balance. This monitoring is especially important for older people over 60 years for preventing diseases occur inactivity and reduce mortality rates. Undoubtedly, it is clear that physical activity affects the occurrence of storage diseases and inactivity while at the same time increase the functional capabilities that can be maintained even after cessation of exercise.

We hypotesed that the process of aging brings with it certain changes in anthropometric, fitness, and functional parameters of persons older than 60 years. Therefore, the primary aim of this study was to determine differences in these parameters in subjects divided into 5 age categories (60-64, 65-69, 70-74, 75-79 and over 80 years) after 60 years of age. A secondary objective was to establish within this classification there are differences between genders of the respondents.

Table 1. General descriptive parameters (mean±SD)

Age	*n*	Height (cm)	Weight (kg)	BMI (kg/m^2)
Men				
60-64	90	178.19±6.65	80.88±9.59	25.50±3.02
65-69	70	177.00±9.35	84.54±13.81	27.03±4.15
70-74	50	174.50±7.71	79.78±11.69	26.27±4.00
75-79	41	175.34±7.79	78.27±13.13	25.39±3.67
80>	21	176.43±8.95	78.48±10.44	25.25±3.20
Total	272	176.64±8.02	81.04±11.93	26.00±3.68
Women				
60-64	90	164.61±6.07	70.02±11.77	25.84±4.18
65-69	48	162.44±6.93	70.69±10.52	26.86±4.15
70-74	56	163.89±7.56	66.75±10.96	24.80±3.38
75-79	33	162.52±8.29	70.67±11.32	26.84±4.51
80>	27	162.19±9.74	67.07±14.15	25.56±5.28
Total	254	163.51±7.33	69.20±11.62	25.90±4.22
Total				
60-64	180	171.40±9.31	75.42±12.01	25.67±3.64
65-69	118	171.08±11.07	78.91±14.27*¶	26.96±4.14
70-74	106	168.90±9.27	72.90±13.01*	25.49±3.74
75-79	74	169.62±10.23	74.88±12.85	26.04±4.10
80>	48	168.42±11.73	72.06±13.78¶	25.42±4.45
Total	526	170.30±10.11	75.31±13.17	25.95±3.95

*- statistically significant difference between age 65-69 i 70-74; ¶ - statistically significant difference between age 65-69 i 80>;

2. Methods

Five hundred twenty six subjects were included in this study, 272 were men (52%) and 254 women (48%). General descriptive parameters of the respondents according to their gender and age categories are shown in Table 1. The age of respondents ranged from 60-91 years. Participation in the study was voluntary and all respondents were able to withdraw at any time of testing. The study was approved by the Ethical Commission of the Faculty of Sport and Physical Education, University of Nis, in accordance with the Declaration of Helsinki. All subjects were first informed about the possible consequences of testing as well as the benefits that this research brings to their age population. Testing of all subjects was between October and December 2011. All subjects were mentally and physically able to participate in the study.

To determine the trend of changes of anthropometric parameters and physical fitness in people aged over 60, we were divided subjects in 5 age groups: 60-64, 65-69, 70-74, 75-79 and over 80 years of age. Their basic descriptive characteristics are given in Table 1. Trained persons for the purpose of this study were first performed a standard interview with a potential respondents individually or in small groups at their homes or in the active center for the elderly. Each of the respondents were first given their demographic characteristics and then joined the determination of anthropometric measures and the Senior Fitness Test (SFT).

Anthropometric measures, measured in accordance with the recommendations of the International Biological Program - IBP. The height of the body is measured with a measuring tape, 0.1 cm accuracy. Body weight was assessed using the decimal scale with accuracy of 0.1 kg. Body mass index (BMI) was calculated indirectly based on the value of body weight and height using the formula BMI = body weight (kg) / body height (m2).

Senior Fitness Test is a battery of tests for assessment functional fitness of older persons. This test evaluates the physiological capacity to perform normal daily activities independently and safely without the appearance of fatigue. Prior to execution of the test subjects first well as doing 10-min warming up led by a trained person, and then perform a complete SFT in the order of tasks referred in this test. This test was validated by Rikli and Jones (1999). The test consists of six measures of physical fitness: 1) the mobility of the shoulder, 2) bent on a chair, 3) eight feet, 4) rising from a chair for 30 seconds, 4) flexion of the elbow joint, 5) two-minute step test. The mobility of the shoulder estimated flexibility of the upper extremities. Each subject performed two test attempts and two attempts which is measured and included in further analysis. The result is the shortest distance between extend middle finger of both hands. Bent on a stool test that evaluates the flexibility of the lower extremities. As with the previous test, each participant performed two test trials and two attempts, which is measured and included in further analysis. The result represents the maximum distance between extend finger tips and toes. Test 8 feet estimated agility and dynamic balance. Each of the subjects performed a pilot trial and two which is measured and later analyzed. The result is the shortest time achieved from the moment of getting up from his chair, traveled eight feet, turn and return to sitting position. Rising from a chair is a test that evaluates the strength of the lower extremities. Each subject has two test and then attempt to access the measurement protocol, which means getting the maximum number that can be brought to the respondent for 30 seconds. Test flexion at the elbow joint estimated the strength of the upper extremities. Each of the respondents first made two test attempts and then completes the test in 30 seconds. As a result of the calculated total number of reps with the entire range of motion performed in 30 seconds. Two-minute step test is a test that evaluates muscular endurance. Respondent faces the wall should do the maximum number of steps to the given height in two minutes. The test is performed only once a respondent during this test does not run but walk as quickly as possible

The collected data were analyzed using statistical software SPSS 17.0 (SPSS Inc., Chicago, IL). Descriptive statistical parameters were calculated for every variables. To determine differences in anthropometric, fitness, and functional parameters compared to half of the respondents and the age category we were used Two-Factor Analysis of variance of different groups (ANOVA). For determining differences among a group of age Bonfferony correction was applied. Statistical significance was $p<0.05$..

3. Results

The largest number of respondents was in the age group of 60-64 years (180 respondents) and males (90 respondents) and women (90 respondents) with increasing age group noticeable of the downward trend in respondents. A statistically significant difference ($p<0.05$) was observed in body weight between subjects from 65-69 years of age and 70-74. Also the difference is noticeable with respondents 65-69 and over 80 years of age ($p<0.05$). Noticeable is the significant difference ($p<0.05$) between men and women regardless of their age group they belong in the body height and weight. By contrast no significant differences were found in all weight height relations between men and women older than 60 years.

In Table 2 we see that when it comes to flexibility, there is no statistically significant difference between respondents of different age after 60 years of old. Also, the parameters for the assessment of agility and dynamic balance (eight feet Test), there is no statistical difference between groups. Respondents are most different in terms of strength in lower and upper extremities. Decrease in strength is observed with the aging process so that the respondents aged 60-64 years significantly differ in the strength of the lower extremities of elderly subjects 70-74 and 75-79 years of age. Also this difference is noticeable if we compare men and women.When it comes to the upper extremities are different groups of people from 60-64 and 70-74 (18.16 ± 4.87 vs 16.37 ± 5.90 repetitions) years of age, both within the same sex and in relation to the opposite gender. The greatest heterogeneity was recorded in the parameters of aerobic endurance where the results of the progressive decline after60 years of age, where they recorded the highest values (78.60 ± 42).

Table 2. Parameters of Senior Fitness Test (mean±SD)

Men					
	60-64	**65-69**	**70-74**	**75-79**	**80>**
Back scratch (cm)	-6.45± 8.90	-9.03± 9.23	-9.85± 12.78	-7.98± 11.61	-10.74± 11.50
Chair sit and reach (cm)	.11± 6.87	-.60± 10.53	4.05± 9.43	1.38± 8.24	.73± 9.00
8 foot up and go (sec)	7.52± 6.54	8.10± 2.91	9.84± 8.88	7.84± 3.34	7.97± 3.34
Chair tand in 30 seconds (sec)	15.34± $4.32^{\Omega\#}$	13.90± 5.87	14.45± 5.05^{Ω}	12.43± $5.24^{\#}$	12.74± 5.10
Arm curl (repetitions)	18.16± 4.87^{Ω}	16.54± 6.19	16.37± 5.90^{Ω}	16.76± 7.08	16.79± 5.11
Two minutes step test (repetitions)	78.60± $42.9^{\Omega\#}$	75.64± $57.80^{‡}$	67.44± 33.92^{Ω}	55.46± $40.97^{\#‡}$	73.68± 35.62
Woen					
	60-64	**65-69**	**70-74**	**75-79**	**80>**
Back scratch (cm)	-7.76± 8.99	-8.19± 9.54	-11.29± 13.13	-10.55± 12.84	-7.38± 9.23
Chair sit and reach (cm)	1.68± 7.99	2.14± 9.99	1.87± 10.08	.45± 10.24	-.12± 8.64
8 foot up and go (sec)	8.79± 8.05	8.64± 2.29	9.09± 3.52	10.59± 4.36	8.93± 3.77
Chair stand in 30 seconds (sec)	14.76± $5.53^{\Omega\#}$	12.47± 6.38	11.49± 4.49^{Ω}	9.77± $4.76^{\#}$	13.68± 6.07
Arm curl (repetitions)	15.19± 4.85^{Ω}	13.51± 5.59	12.98± 5.47^{Ω}	11.97± 4.46	14.46± 6.07
Two minutes step test (repetitions)	68.04± $32.7^{\#\Omega}$	56.56± $36.34^{‡}$	49.28± 33.31^{Ω}	40.71± $28.59^{\#‡}$	49.87± 28.92

*- statistically significant difference between age 65-69 i 70-74; ¶ - statistically significant difference between age 65-69 i 80>; †- statistically significant difference between age 60-64 i 65-69; ‡- statistically significant difference between age 65-69 i 75-79; Ω- statistically significant difference between age 60-64 i 70-74; # - statistically significant difference between age 60-64 i 75-79

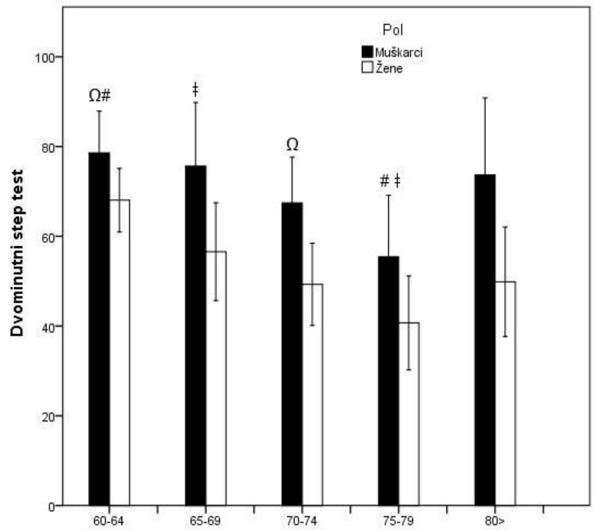

Figure 1. Differences between men and women

4. Discussion

Promotion of healthy lifestyles of elderly persons has risen in importance due to the dramatic enlargement of these people during the past two decades. The level of physical activity is often used as a parameter for monitoring and assessing population health and almost always associated with a medical condition. This monitoring is especially important for older people to prevent many illnesses, but emergence inactivity and reducing mortality rates [2].

The results of our research show that the total body weight increased from 60-70 years of age in men whereas in women unchanged (Table 1) which was confirmed earlier studies Guo, Zeller, Chumlea, & Siervogel, (1990).However, this must be taken with caution because the study Visser et al. (2003) reached opposite conclusions in terms of body mass a person over 60 years of age. BMI values suggest that it is the respondents excessive body mass (BMI> 25) regardless of gender, which may lead to the emergence of various chronic diseases and reducing the capacity [1], because obesity is considered one of the most important public health problems and to evaluate the second most common cause of mortality that can successfully prevent [2]. Unlike studies Perissinoto et al. (2002) where a lower BMI between the ages of 65-75 than in the period between 75-80 years of age in our study were recorded higher values in the 65-75 period compared to the period after the 75th years of age. The results of these studies have only confirmed the trend in most countries where the recorded increase in the number of obese older persons in the past two decades, so has reached epidemic proportions.

In our study has noticeably decreased muscle strength in men and women in the lower and upper extremities with progressive increase in the number of years. Decrease in muscle strength during the aging process is the result of significant loss of muscle mass which may cause the decrease in physical activity but also increase the risk of falls and injury occurrence in the elderly. With the increasing sedentery lifestyle comes to a significant loss of muscle mass and increased body fat, regardless of gender. The results of this study clearly show that men and women with increasing age are becoming less active as reflected by their muscular strength and endurance. Namely, one may observe a statistically significant decrease in aerobic endurance values in our subjects 60-64 years old and subjects older than 75 years.

In this study, we found that there was an increase in the amount of adipose tissue, reducing the level of muscle activity and decreased muscle strength and endurance of the aging process. The combination of these parameters which are part of risk group for cardiovascular and respiratory diseases of our respondents are exposed to many times greater risk of developing these diseases. Therefore their work ability and physical condition are reduced. Negative factors that affect physical performance, such as the excessive amount of body fat should remove before the situation arises that can not be corrected. Reduction of subcutaneous adipose tissue prevents the decline in physical fitness and work capacity. Physical activity and training keeps you fit and functional fitness, which decreases the aging process.

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INDUSTRY TRENDS AND DEVELOPMENTS IN REPUBLIC OF CROATIA

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Abstract
This paper attempts to present industry trends in Republic of Croatia and development basis and opportunities. From the point of view of nowadays market situation development should be understood as the strategic plan directed on strengthening of market positions of the companies in industry sector- as effective satisfaction of requirements of its clients and achievement of high business results. Small enterprises play an extremely important role in what concerns boosting economic growth and generating employment. The effective development is necessary for achievement of competitive advantages of industry. For the successful decision of practical realization of industry it is necessary to formulate accurately its purposes, to allocate indicators and current state of industry. Fundamental indicators and elements of industry are demonstrated through example and experiences of Croatian industry in 2009, 2010, 2011 and activities for the improvement of the industry sector in 2012.

Keywords:
Industry, Croatia, Development, Indicator, Improvement

1. Introduction

Industry sector is key part of economy growth in world like as in Croatia. Industry has been changing because of new areas of industrial production, new technologies and economy trends that are based on knowledge- intellectual capital as a key development factor. There is historical and political role of industry trends in Republic of Croatia- change of political system and war at beginning of 1990 had impact on slowing down and stagnation not only of industry, but on total economic growth. Results are devastated factories, stopping of production, lack of new technologies, new products and innovations, educated experts; loss of existing markets for exports, process of transition and privatization ore not implemented well. These are just only some factors that slowed down industrial development and influenced on negative industry trend of modern times that should be transformed and changed.

2. Croatian industry

Croatian industry is intensely changed- over the last ten years has mostly been characterized by radical manufacturing and productivity growth. The effects of its restructuring are evident in many areas, e.g. strengthening exports, development of production processes, quality standards introduction, meeting ecology requirements and achieving cost efficiency. These intensive changes are part of restructuring process and adaptation to the global competitive environment and accession negotiations with the EU, which include local industry and society adjustments to European standards. “The consequences of the global financial crisis were first noticed at the end of 2008, taking the form of decelerating growth in terms of manufacturing volumes, productivity, employment and foreign exchange of goods in 2009. This negative trend in the industry production has been observed until the end of 2010 when the further production decrease was slowly brought to a halt [1].”

“Industry generates about 20% of Croatian GDP and employs around 277 000 employees, or 25% of total employment in Croatia. A significant proportion of the total revenue realized by the production of food and beverages, manufacture of petroleum products, chemicals and chemical products, metals and building materials, electrical and optical equipment, manufacture of paper, printing, and shipbuilding [2].”

Industrial products represent almost 97% of Croatian exports, which along with the fact that industry has the largest share in GDP in Croatian, shows that the industry is leading branch of the Croatian economy. Despite this fact, Croatian industry in not developed enough. In last two years industrial small and medium enterprises had been rather dynamic. The main characteristic of this period notes the increased number of closed companies which couldn’t deal with recession. Decrease of unemployment rate and increase in foreign exchange of goods is expected in the upcoming period. Assumption is that notable positive shifts in the international market would rapidly ensure positive effects on the Croatian economy, especially on exporters.

It is important to support science and technology development through innovations and inventions - through finding of new demand and entering to a new markets, implementation of joint investment and establishing strategic partnerships with foreign companies modern technologies and new products, organization improvement, and specialization and so on. A competent workforce is highly educated professionals in the field of engineering and computer technology, and technology centers with technical faculties of Croatian universities are a good basis for foreign investment in advanced technology. More intense activities, related to encouraging direct foreign investments and transfer of technologies are expected in all industries and industrial activities related to environmental protection, waste management, power industry and energy efficiency. Good opportunities for investment exist with the privileges of the free trade zones and industrial zones, which will further motivate the industry to invest and the entry of new technologies and new products for export, on which the forecasts are based, and further growth of industrial production in Croatia.

3. Indicators of Croatian industry

For better understanding of industry sector in Republic of Croatia it is important to see current state and economic trends. For basic information there are key indicators about industry that are shown in Table 1. and discusses in text below.

Table 1. Key indicators of Croatian industry in 2009. and 2010. [3]

Indicators	2009.	2010.
Total number of employed persons in industry	460654	423204
Average monthly Net salaries (Kn)	4805	4815
Average monthly earnings Gross salaries (Kn)	6890	6819
Value of products sold (*Thousand kuna)*	116 906 179	-
Export (Mln.Euros)	7 529	8 902
Import (Mln.Euros)	15 220	15 127

In Republic of Croatia in 2009 there was economically active population of 1 498 784 employed persons, and in 2010 total number was 1 432 454. According to Table 1. the total number of persons employed in industry in 2010 was 423 204 and in 2009 was 460654. "It is by 9% lower than in December 2009 compared to December 2010. "In 2011 number of employers is decreased for 3,2% [4]." Accordance with NKD (statistical classification of economic activities) statistics are different. "According to the NKD 2007. sections, in December 2010, as compared to December 2009, the number of persons employed in Mining and quarrying was by 16.2%, in Manufacturing by 5.8% and in Electricity, gas, steam and air conditioning supply by 1.5% lower[5]."

Average monthly total gross earnings in Republic of Croatia in 2009 was 7.711 HRK and in 2010 7.679 HRK. Average Net salaries in 2009 were 5311 HRK and in 2010 5343. In Industry Average monthly earnings Gross salaries in 2009 were 6890 HRK in relation with 2010 salaries were 6819 HRK. Average Net salaries in industry in 2009 were 4805 HRK and in 2010 were 4815 HRK- ranging between 2,787 HRK in the clothes manufacturing industry and 8,048 HRK in the extraction of petroleum. In comparison of sector of industry and services average gross salaries in service in 2009 were 8145 HRK, in 2010 were 8119 HRK, and net salaries in 2009 were 5586 HRK, in 2010 were 5609 HRK. Comparison of total earnings in Republic of Croatia and industry and service sector shows that industry is most undeveloped and earnings of employers are lowest. Even industry in last twenty years had reduced importance in Croatian economy; industry is still one of the main levers of economic growth in most countries around the world. Croatia should develop and invest sector of industry, especially in conditions of recession. One of main reasons might be low level of implementation of new technologies and insufficient knowledge in industry as a key factor of development.

According to the CBS 2009. reports, in 2009, as compared to 2007 and 2008 the value of products sold is decreased. In 2007 value of products sold was 124 153 918, in 2008 was 134 399 6202 and at the beginning of recession in 2009 was 116 906 179. That negative economic trends shows stagnation of industry. For development of industry sector it is necessary to restructure industry. Croatian industry cannot be based on traditional industries and economies with cheaper labour. The lack of industrial policy has result decrease of the economic growth of Croatia as well as the transformation of the traditional industry towards new industries. "The Croatian industry as a whole has to be restructured towards "new industries" based on competitiveness achieved through knowledge, innovation, creativity, sustainable development and advanced technology in all areas of operation [6]."

In January 2011, industry (sections B, C and D) employed approximately 236,158 persons (i.e. 21% of total employment with companies) in 13,870 active companies (12% of their total number) and accounts for 18% of Croatian GDP.

4. Value of industrial products

Industrial products are classified in three sections: B, C and D section. Statistical values of each sector are shown below in Table *2.*

Table 2. *Value of industrial products sold and export* [3]

	2009.				**2010.**			
	Number of enterprises	*Number of local units*	*Value of products sold according to NIP 2009., thousand kuna*		*Number of enterprises*	*Number of local units*	*Value of products sold according to NIP 2010., thousand kuna*	
			Total	*Of that, abroad (export)*			*Total*	*Of that, abroad (export)*
B *Mining and quarrying*	103	114	4 230 230	278 950	101	112	5 302 136	261 524
C *Manufacturing*	3 317	3442	99 847 726	36 522 129	3 175	3 307	103 514 089	44 399 295
D *Electricity, gas, steam and air conditioning supply*	148	200	11 341 630	40 915	147	199	11 276 823	40 379
E *Water supply; sewerage, waste management and remediation activities*	109	112	1 486 593	4 385	112	116	1 536 777	1 726
TOTAL	3503	3682	116 906 179	36 846 379	3 367	3 555	121 629 825	44 702 924

Table 2. shows value of industrial products sold and export in 2009 and 2010 of industry sector by sections: B-mining and quarrying, C-manufacturing, D-electricity, gas, steam and air conditioning supply, E-water supply; sewerage, waste management and remediation activities. Because of recession number of enterprises is decreased in 2010 because many of them weren't capable to deal with new economy. Some sectors grow their activity, but many have stagnation of development. As new technologies become ubiquitous, firms must adopt and assimilate them to gain and sustain competitive advantage. To test this framework empirically, in a context (industrial sector) in which a new technology has had widespread influence, there are differences in strategic responses to this new technology, and there are differences in organizational resources. There are a large variety of new manufacturing technologies, not all of which are computerized. The new manufacturing technologies allow a drastic shortening of this life cycle in both the design and the production stages. Croatian industry in characterized by lack of new technology and manufacturing processes. Computerization and robots (can offer significant advantages in flexibility, quality, labor and safety in manufacturing processes in not jet implemented in Croatian firms.

Because of that domestic market is not competitive on foreign markets and rate of export of industrial products is very low. Table 2 shows that in almost every sector rate of export in 2010 is decreased in comparison with 2009.

On the other hand, other opportunity for increase of value of industrial products that firms often compete is through new products. In terms of product life cycle theory, they start by introducing a new, highly profitable product and proceed to the growth stage. Croatian industry is not leader in new products and don't have developed system of creating new products.

5. Activities for the improvement of the industry sector in 2012

Industrial production fell for 1,8%in the first three quarters of 2011th year fell by another 1.8% regarded to the first three quarter of 2010, after the decrease in 2009. and 2010. In the atmosphere of the economic situation in the EU and its influence on Croatia, in 2012 can be expected to continue a three-year trend, and further developments will depend on the economic situation in the Euro zone and the measures of Croatian Government. For improvement there are some activities that can improve current state of industry production in 2012:

- In cooperation with Ministry of Entrepreneurship it is necessary to promote and strengthening entrepreneurship and creates an entrepreneurial climate. Through entrepreneurial associations and other communities in the Department of Industry encourage for stronger engagement and creating strategies and their implementation in order to establish the economic system that is consistent and follow the sequence of global market competition.
- Actively implement measures to support organizations related to the funding and financing of projects and programs that encourage small and medium enterprises.
- To encourage the exchange of experiences in order to avoid mistakes and failures and to ensure access of Croatian clusters to European market, as well as to promote and encourage cooperation between clusters with the scientific community in the Republic of Croatia.
- Reform of the high-school professional education and high education program within the meaning of rating of market changes in the occupational structure and programs;
- “Application of knowledge and innovations in product development, investing in new designer product solutions, investing in high-technology solutions, and finally, sales and distribution in an optimal way; forming of industrial design centre which will offer help to implement design by means of direct engagement of industrial designers in the product; forming of Croatian certification centre” [6]
- Support the main directions of development - strengthening of entrepreneurial zones, completion of existing and new construction facilities, especially use of products for export and substitution import, credit lines for entrepreneurs, development and support of start-up projects, an increase of incentives, training and education for entrepreneurs, export orientation, and construction of business centers, zones and incubators. These actions will support development of entrepreneurial zones in order to attract domestic and foreign investors
- Work on the project " Developing innovative business” simultaneously seek that Croatian Chamber of economy members have the most benefit from these projects, in terms of consultations, meetings with relevant authorities, harmonization of views and attitudes, etc.

6. Conclusion

Republic of Croatia should recognize opportunities that can expand industrial production. Croatia in small country and it should not base it’s production through massive production, because small economy can’t compete large and cheap economies from China or India or large economies of EU or USA. The production should be based on scientific-research work with high technology, making quality Croatian brands and creation of business climate which will attract direct foreign investments. “As new technologies continue to proliferate, firms in diverse industries increasingly must respond” [7]. Future economic rents and competitive advantage rests on the organizational ability to assimilate new technologies in a timely manner. It is important to affect rates of innovations and investments (especially in equipment and technologies). It is possible to see how the optimum concept for creating of investment opportunities has not been reached in Croatia. So, it is important to support development and investments in industry as a mail wheal of Croatian economy.

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THE EFFECT OF TWO MONTHS TREATMENT OF DIVINE HEALTH PROGRAM ON THE PEAK EXPIRATORY FLOW OF STUDENTS AGES BETWEEN 11 AND 14

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Abstract
The aim of this study was to determine if Divine health program, which is based on two breathing techniques, has an influence on the peak expiratory flow (PEF). The program was tested on the sample of 38 students, ages between 11 and 14, they were all healthy, without any physical disabilities. The secondary aim was to teach students how to breathe properly and also to educate them how important it actually is. The variables used in the survey were: PEFI (peak expiratory flow initially), PEFF (peak expiratory flow finally), RPEF. PEF was measured by assess peak flow meter.
According to the results we can conclude that Divine health program, in the period of eight weeks (2 x 10 minutes a week, during the extracurricular activities), is not enough to get statistically important value increase in PEF variable. Concerning the length and frequency of the treatment, those results were expected. Nevertheless, during that time period, the students learnt the deep breathing technique and rapid breathing in every second (kapalabhati).

Keywords:
deep breathing, kapalabhati (rapid breathing per second), PEF

1. Introduction

Divine health program is a systematic and ancient system that was founded by Sri Siva Kumar Swamiji Nasimath and Swami Urgaya (longterm qualified meditation and breathing techniques teachers, founders of international charity organization Divine Energy Park). This program is intended for all people [1]. Divine health program consists of breathing techniques, psychophysical exercises and meditation, and the aim of the program is to enable every individual to set himself or herself free of deeply rooted stress and trauma in an easy and practical way and to achieve the harmony of all organic systems [1]. We used two breathing techniques in this study; deep breathing and a technique of forced exhale per second which is called kapalabhati (rapid breathing) or the Skull Shining Breath.

Breathing is a process of taking the air into and expelling it from the lungs as a consequence of three-dimensional changes in thoracic and abdominal cavities [2].
According to Kosinac (2008), from physiological point of view, breathing has three vital phases: oxygen and carbon dioxide diffusion between the alveolus and blood, transmission of oxygen and carbon dioxide by blood and tissue liquids to the cells and back, and the tissue breathing. The first process is called external breathing or lung ventilation. The second process, gas transmission, is a blood circulation in the function of cardio-vascular system, and the third process is internal bleeding or tissue breathing [3]. According to Kosinac (2008), breathing exercises present a process that can be identified as a degree of strength needed for the movement (of pectoral muscles and ribs), pectoral cavity and heart contents, motor (diaphragm) and lower abdomen.
According to Urgaya (2011), there are four kinds of breathing. Low or abdomen breathing is the breathing during which the stomach expands by inhaling and it shrinks by exhaling. Diaphragm moves down while breathing in and it moves up while breathing out. Middle or pectoral breathing is the breathing in which pectoral cavity expands and abdomen shrinks while inhaling; while exhaling pectoral cavity shrinks and abdomen expands. In comparison to the abdomen breathing, this kind of breathing wastes more energy, does not massage internal organs and brings less oxygen in the body. High or clavicle bone breathing is the breathing in which the top part of the pectoral cavity is used, during that process pectoral and clavicle bones are moved. Deep breathing is the breathing that includes all three kinds of breathing; while inhaling abdomen extends first, then pectoral cavity, which is followed by the movement of pectoral and clavicle bones. Diaphragm moves down with the inhale and it moves up with the exhale, going back to the initial position. Kapalabhati is a technique of fast and forced expiration per second. Acharya Balkrishna and co-workers tested the effects of breathing techniques on various diagnoses, such as obesity, diabetes, high blood pressure, carcinoma, kidney function, arthritis, spondilits, heart diseases etc. It was tested on the sample of 10039 subjects. After seven days of intensive

breathing the final testing showed the following: the tests on the function of lungs showed that 600 people improved the condition of respiratory system, 59 % of obese participants lost 2 kg, 34 % of them lost 10 kg, 43 % lost 2 to 5 kg and 6 % lost 5 to 10 kg. 457 of 743 participants with kidney diseases showed improvement, and 286 people showed improvement beyond expected values. According to Acharya Balkrishna (2007), kapalabhati cures heart and brain diseases, asthma, sinuses and other problems with breathing, constipation, it also regulates blood sugar, artery blockading. Doing kabalabhati exercises on regular basis cures constipation and diabetes without taking medicines [4].

In 2005 Joseph, C.N. and his co-workers tested the effects of deep slow breathing on the artery bar reflex and blood pressure on people with hypertension; it was tested on 20 subjects in the experimental group and 26 subjects in the control group. They proved that slow breathing lowers blood pressure and improves the sensitivity of bar reflex.

Acharya Balkrishna and co-workers tested the effects of breathing exercises on the functions of respiratory system; there were 500 subjects who had problems with respiratory system. There were 300 subjects in the experimental group who were tested before and after the camp. Forced vital capacity, maximum willing ventilation and peak expiratory flow rate were measured in this study. The function of the lungs at 196 subjects showed the results that were under average. They practiced breathing exercises 2 hours in the morning and 2 hours in the evening, and test analysis showed statistically important difference of 42.9% in the values of forced vital capacity, maximum willing ventilation and peak expiratory flow rate. PEF is a person's maximum speed of expiration, which is achieved by the maximum inhale followed by the maximum forced exhale; and it is an indicator of ventilation, that is, speed of the air flow through the lungs.

PEF is a good indicator of the lungs' condition and possible obstruction of the airways. PEF measurement method was introduced forty years ago when the first PEF meter was produced. The expected (or 'normal') PEF value is not the same for everyone; it depends on a person's age, sex and height. There are several tests that are used for the assessment of the respiratory system function. These tests are often used for the assessment of the functional or working abilities and diagnosis or for the effects of kinesiological treatments. People who are better adjusted to the physical efforts by doing systematic exercises have more effectual ventilation. Ventilation values change during the childhood and puberty simultaneously with the changes in anthropometrical characteristics. During that period the development of the ventilation values of lungs can be influenced by exercising and training. Lungs function testing is an objective way of checking the condition of respiratory system, it is used in diagnosis, evaluation of therapy and clinic-pharmacology tests. The tests are used for measuring the lung volume and the air flow (or the resistance to the air flow) in the airways. The results of the tests are compared to the referent (normal, theoretical) values, according to sex, age and height..

2. Methods

The samples of the study were 38 students, ages between 11 and 14, who attend Primary school Vrpolje-Perković. Using t- test for independent variables, we concluded that there are no statistically important differences between sexes, so the experimental group consisted of 20 students (10 boys and 10 girls), and the control group consisted of 18 students (9 boys and 9 girls).

For the assessment of the peak expiratory flow values 1 test was used, PEF, PEFI in the initial measurement, and PEF in the final measurement.

Peak flow meter Assess was used as a device for measuring the peak expiratory flow. The measurement took place in the school gym.

During the test the subject is standing and then takes a deep breath in through the mouth, puts the meter in the mouth and performs the fast expiration. The highest of three readings is used as the recorded value of the peak expiratory flow rate. It is measured in l/mm.

Note: the results of the PEF measurement can be falsely high values, so-called 'spitting maneuver,' that is by throwing the air into the PEF meter by tongue and cheeks. It is advisable to check the PEF measurement technique with children in order to be sure in the correctness oft he results.

The initial measurement was done in February 2012, and the final measurement was done in April 2012. After the initial tests, certified Divine Health Program teacher taught the students of the experimental group two breathing techniques; deep breathing technique and technique of fast breathing per second (kapalabhati). Experimental group practiced breathing techniques in the period of two months, 2 times 10 minutes a week, as an extracurricular activity.

Deep breathing technique is performed while sitting down in good posture with legs crossed, eyes closed, hands positioned on knees in the supination position. While breathing in the air, it expands stomach first, then the thoracic cavity and thoracic and clavicle bones. Diaphragm moves down while breathing in and it moves up while breathing out, going back to its initial position. The deep breathing technique is performed during the period of 5 minutes. The technique of fast exhaling per second (kapalabhati) is done while sitting down in good posture with legs crossed, eyes closed, and hands positioned on knees in the supination position. The inhale is natural (the stomach is in its initial position), and the exhale is forced, with the abdomen. While inhaling we contract all stomach's muscles and lower abdomen muscles (stomach must move towards the spine as far as it can). We do not hurry or strain ourselves. The rest of the body must be calm and relaxed (face, neck, arms), only the chest lightly moves up. We make one exhale per second [1]. The exercise lasts 5 minutes. Note: if the chest moves down, we breathe with the upper part of lungs which in not the proper way. The proper way to do it is to breathe so that stomach moves towards the spine while exhaling.

Arithmetic mean, standard deviation (SD), the lowest and the highest results (min and max), α3 (asymmetry coefficient), α4 (coefficient) were calculated by descriptive analysis. Distribution normalities were tested by Kolmogor-Smirnov procedure. Statistical importance of difference between the initial and the final values of the peak expiratory flow rate and the influence of Divine Health Program was tested by t-test for independent variables.
The results were processed by the program Statistica 8.0 (StatSoft, USA).

3. Results and discussion

Table 1. Descriptive analysis of the distribution normalities using K-S test (n=38)

	PEFI	PEFF	RPEF
A	353,95	395,00	46,05
Min	250,00	270,00	-60,00
Max	500,00	570,00	130,00
SD	66,76	74,22	46,41
α_3	0,29	1,49	-0,33
α_4	-0,53	0,94	-0,27
max d	0,140	0,104	0,139
p	p > .20	p > .20	p > .20

Legend: PEFI- peak expiratory flow, the initial measuring; PEFF- peak expiratory flow, the final measuring; RPEF- difference between the initial and the final peak expiratory flow

Kolmogorov-Smirnov test shows that the variables are normally distributed, that is, they do not significantly deviate from the normal distribution, because the maximum deviations between cumulative and theoretical proportions (MaxD) are lower than border deviation value (0,21). Due to that, variables are a good precondition for the further statistical data analysis. If we look at the arithmetical means, we can see an increase of 46,05 in the final measurement of the peak expiratory flow (PEFF) in comparison to the initial measurement of the peak expiratory flow, that indicates increase oft he results values with all subjects in experimental and control group. There is also greater dispersion of the final results in the standard deviation values.

Table 2. t- test results for independent samples between experimental (n1=20) and control group (n2=18) in PEFI, PEFF i RPEF

	PEFI	PEFF	RPEF
AS_1	348,50	395,00	46,50
AS_2	360,00	405,55	45,56
SD_1	67,84	78,37	30,83
SD_2	66,95	71,14	60,22
t	-0,52	-0,43	-0,06
df	36,0	36,0	36,0
p	0,60	0,66	0,95

Table 2 shows the values of t-test on independent samples that were applied for differentiating the control and the experimental group in the initial and the final measuring of PEF (peak expiratory flow) values. We can see that there was an improvement of the PEF results in both the experimental and the control group, but it is not statistically important. Results also do not show statistically important differences between the initial and the final measuring. Due to the fact that the increase of the PEF values in the experimental group, in comparison to the control group, is statistically insignificant, we can conclude that Divine Health Program did not have a statistically important influence on PEF variable, which was expected considering the length and frequency oft he treatment.

4. Conclusion

The influence of Divine Health Program on the peak expiratory flow (PEF) was tested in this study. It was tested on the sample of 38 students, ages between 11 and 14. All students were healthy, without any visible physical disabilities or aberrations.
Using T test on independent samples we concluded that Divine Health Program does not have a statistically important influence on the peak expiratory flow (PEF) in a period of 8 weeks (2x10 minutes a week, as an activity that is not included in the obligatory school subject). Those results were expected considering the length and frequency of the treatment. According to that, we can conclude that the given time period of 8 weeks was not long enough to be able to get statistically important higher PEF (peak expiratory flow) values. Nevertheless, that period was long enough to teach children the deep breathing technique and

kapalabhati technique and to educate them about the importance of breathing for human body and health.

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ANALYSIS OF ERASMUS IMPLEMENTATION WITHIN LIFELONG LEARNING PROGRAMME

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Abstract
The reality of world today is described by significant, dynamic and complicated changes during the past decades. In such situation, there is an increasing need for the learning of individuals and development of educational institutions. As a result of the globalization challenges, the European Union has recognized education and knowledge as essential elements of the knowledge based society and economy. The objective is to make the European Union the most dynamic and competitive knowledge society in the world. Mobility of individuals in higher education of today has a clear role to develop knowledge based society and intercultural dialog within academic community, to discuss cultural values and to face the worldviews. Erasmus programme provides the opportunity to take part in study exchange visits at partner institutions throughout Europe. The aim of this work is to point at the need of the Erasmus Programme and more active involvement of educational institutions into the process of mobility in order to better creation of its future. This work analyses Erasmus implementation within Lifelong Learning Programme and shows the most active countries in this process.

Keywords: Erasmus programme, Mobility, Higher Education, European Union, Knowledge

1. Introduction
The development of academic mobility as well as any other form of international exchange could lead the world to be a better place. Erasmus programme has in time become one of the most popular exchange programmes. The university is a place of constant self-evaluation and growth so Erasmus helps Europe's universities and other educational institutions to work together towards modernizing curricula, funding and improving the quality of higher education. A partnership within the higher education sector encourages different models of joint activities and innovative projects at international level and also contributes to more openness and internationalization. Involvement in Erasmus mobility contributes to development of students' technical communicational and linguistic skills, to team work capabilities, problem solving, independence and self-initiative boost.

2. Lifelong Learning Programme
"The Lifelong Learning Programme is the educational programme established by the European Commission for the purpose of supporting learning opportunities across Europe. The Lifelong Learning Programme budget will be used for funding actions such as study exchanges, study visits and networking activities. Projects are intended not only for individual students and learners, but also for teachers, trainers and all others involved in education and training."[1] Within LLP there are sub programmes focuses on different levels of education and training and continuing previous programmes: Comenius for schools, Erasmus for higher education, Leonardo da Vinci for vocational education and training and Grundtvig for adult education. This work research Erasmus programme for higher education.

3. Erasmus programme
The Erasmus Programme (European Community Action Scheme for the Mobility of University Students) is a European Union exchange programme for higher education students, teaching and non-teaching staff and institutions established in 1987. The Erasmus Programme, together with other independent Programmes, was incorporated into the Socrates programme established by the European Commission in 1994. "The Socrates programme ended at the end of 1999. and was replaced with the Socrates II, Programme which was replaced by the Lifelong Learning Programme 2007–2013 on 1 January 2007." [2]
The programme's main objective is to improve the quality and increase the number of student and teaching and non-teaching staff mobility throughout Europe. It also aims at strengthening the multiculturalism the personal meeting of people from different countries. Erasmus encourages student and staff mobility for work and study, and promotes trans-national cooperation projects among universities across Europe.
The European Union finances the programme. "The budget of the Lifelong Learning programme is approximately 7 billion € for the years 2007 to 2013 with 440 million € annually going to the Erasmus-programme." [3]
The programme is open to the 27 Member States of the European Union but also countries with an EU associated status with EU member country. Erasmus actions include support for: **"**Students

(studying abroad, doing a traineeship abroad, linguistic preparation), Universities/higher education institution staff (teaching abroad, receiving training abroad), Universities/higher education institutions working through (intensive programmes, academic and structural networks, multilateral projects) and Business (hosting students placements, teaching abroad, participating in university cooperation projects)" [4]

Higher education institutions which want to participate in Erasmus activities must have an Erasmus University Charter. The Charter aims to guarantee the quality of the programme by setting certain basic principles.

Student mobility for studies enables students at higher education institutions to spend a certain period of study of between 3 months and 12 months in another participating country. Student mobility for placements enables students at higher education institutions to spend a placement period between 3 months and 12 months in an enterprise or organization in another participating country.

Teaching staff mobility enables staff to spend a teaching period between 1 day - and 6 weeks or at least 5 teaching hours at a higher education institution in another participating country. Staff mobility for training enables teaching and other staff of higher education institutions to spend a period of training between 5 days and 6 weeks in an enterprise, organization or a higher education institution in another participating country.

The Erasmus Intensive Language are specialized courses in the less widely used and less taught languages organized in the countries where these languages are used as teaching languages at higher education institutions. The languages which are not eligible for EILC are English, German, Spanish and French.

An Intensive Programme is a short programme of study which brings both students and teaching staff from higher education institutions of at least three participating countries. It can last from 10 continuous full days to 6 weeks of subject related work.

Erasmus Preparatory Visits were introduced as a new Erasmus action at the beginning of the Lifelong Learning Programme in 2007. "The main objective is to help higher education institutions establish contacts with prospective partner institutions in other participating countries and prepare participation in the different actions of the Erasmus programme. These grants can be used to visit new prospective partner institutions, or an enterprise, to establish future cooperation." [5]

3. Erasmus implementation

The academic year 2007./08. was the first year of Erasmus programme under the newly established Lifelong Learning Programme. Since the beginning of the Erasmus Programme in 1987 the number of students and teaching and non-teaching staff going on mobility has increased every year and continued up to now that is shown in Table 1.

Table 1. Implementation of Erasmus programme [6]

Erasmus actions	2007. /2008.	2008. /2009.	2009. /2010.
STUDENT MOBILITY	183000	198600	213266
studies	163000	168200	177705
placements	20000	30400	35561
STAFF MOBILITY	32000	36400	37776
teaching assignments	27000	28615	29031
training periods abroad	5000	7800	8745
INTENSIVE LANGUAGE COURSES	4894	5200	5386
INTENSIVE PROGRAMMES	11822	13560	16984
ERASMUS PREPARATORY VISITS	56	200	309

Table 1. shows a statistical overview of the implementation of the Erasmus programme in the academic years 2007./08., 2008./09. and 2009./10. The table shows the overall performance of all the different types of actions within the Erasmus programme (student and staff mobility, intensive language courses, intensive programmes, and Erasmus preparatory visits) and compares results with the results in the previous years.

In the first year under the Lifelong Learning Programme 183000 students went abroad to study or to do a placement in an enterprise. Next academic year 2008./09. there has been an increase of 8.7%. In 2009. /10. there has been an increase of 7.4% compared to the previous academic year. In 2007./08. there were 32000 staff mobility. 2008./09. represents an increase of 13.57% compared to the previous year. In next year 2009./10 there has been an increase of 3.8%. In 2007./08. 4894 students participated in EILC courses. Next year there has been an increase of 6.4%. and in 2009./10. an increase of 3.4%. The total number of participants in the Intensive Programmes organized in 2007./08 was 11822, including both students and teachers. There has been an annual increase of 14.7 % compared to the previous academic year and an annual increase of 25.25 % compared to the 2008./09. In the academic year 2007./08. 56 Erasmus Preparatory Visits took place. In the next 2008./09,

there has been an significant increase of 257%. and in 2009./10., there has been a lower increase of 54.5% compared to previous year. In the period under review there has been an increase of all Erasmus actions from 2007 to 2010.
Currently 33 countries are participating in the programme and almost all higher education institutions in Europe are involved. The most popular countries with a highest number of outgoing students and teaching and non-teaching staff of all the different types of actions within the Erasmus programme are shown in Table 2.

Table 2. The most popular countries with a highest number of outgoing students/teachers [7]

Erasmus actions	2007. /2008.	2008. /2009.	2009. /2010.
STUDENT MOBILITY Studying abroad Placements	Germany (26286) Spain (22556) France(3298)	France (28283) Spain (24399) France (4723)	Spain (31158) Spain (27448) France (5787)
ERASMUS STAFF MOBILITY Teaching Assignments Staff Training	Poland (3112) Germany(2681) Poland (652)	Poland (4341) Poland (3079) Poland (1262)	Poland (4443) Poland (2967) Poland (1476)
Erasmus Intensive Language Courses	Germany (1016)	Germany (991)	Germany (922)
Erasmus Intensive Programmes	France (1120) Belgium (292)	Germany (905) Germany (291)	Italy (1091) Italy (466)
Erasmus Preparatory Visits	-	Bulgaria (39)	Germany (61)

Table 2 provides a statistical overview of the implementation of the Erasmus programme in the European countries in the academic years 2007./08., 2008/09. and 2009./2010. It analyses the percentage of increase/decrease and compares results with the results in the previous years.
In student mobility the biggest share of outgoing Erasmus students in 2007./08. came from Germany. In 2008./09. France sent the 8% more students. The largest number of outgoing Erasmus students was in 2009./10. from Spain with a 10, 6 % increase. Spain is a country that sent the highest number of students on Erasmus student mobility in all academic years. There was every year an increase, in 2008./09. was an increase of 8,17%, and in 2009./10 an increase of 12,5%. The country with the highest number of outgoing students on Erasmus placements was France in academic years. There was every year an increase, in 2008./09. was an increase of 43,2% and in 2009./10 an increase of 22,5%.
Poland is the most significant country in Erasmus staff mobility. It is the country with the highest number of outgoing staff mobility's in all academic years. In 2008./09. there has been an increase of 39,5%, and in 2009./10. significantly reduced an increase of 2,34% compared to previous year. The highest number of outgoing teaching assignments in 2007./08. was in Germany, but next two academic years was again recorded in Poland. In 2008./09. There has been an increase of 14,8% and in 2009./10. decrease of 3,64%. The highest numbers of outgoing mobility's for staff training were also from Poland in all academic years. There has been a significant increase in 2008./09. of 93,55% and 16,95 % in 2009./10.
Germany is most significant country for Erasmus Intensive Language Courses. It sent the highest number of EILC participating teachers in all academic years. Unlike others Erasmus actions there has been every year decrease. In 2008./09. participated 3,47% less teachers and in 2009./10. 7% less compared to previous year.
In Erasmus intensive programmes France is the country with the highest number of outgoing students and Belgium with outgoing teachers in 2007./08. In 2008./09. the highest number of students and teachers participating came from Germany. There has been decrease of students (20,2%) and unnoticeable decrease of teacher (1%). In 2009./10. country with the highest number of participating students was Italy. There has been recorder an increase of students (20,5%) and teachers (60,30%).
There is no information about preparatory visits in 2007./2008. But in next 2008./2009. Bulgaria sent the highest number of participating people on preparatory visits. In 2009./10. it was Germany, with an notable increase of 56,41 % compared to previous year.
The most popular countries with a highest number of incoming students and teachers of all the different types of actions within the Erasmus programme are shown in table 3.

Table 3. The most popular countries with a highest number of incoming students/teachers [8]

Erasmus actions	2007. /2008.	2008. /2009.	2009. /2010.
STUDENT MOBILITY Studying abroad Placements	Spain (31129) Spain (27204) France(3389)	Spain (33172) Spain (28175) Spain (4997)	Spain (35389) Spain (29328) Spain (6061)
ERASMUS STAFF MOBILITY Teaching Assignments Staff Training	Germany (3474) Germany (2927) UK (615)	Germany (3781) Germany (2913) UK (896)	Germany (3775) Germany (2947) UK (969)
Erasmus Intensive Language Courses	Italy (986)	Italy (1345)	Italy (960)
Erasmus Intensive Programmes	-	-	Italy (1483) Italy (555)
Erasmus Preparatory Visits	Germany (21)	Bulgaria (39)	Turkey (56)

Table 3. provides a statistical overview of the implementation of the Erasmus programme in the European countries in the academic years 2007./2008., 2008./09. and 2009./10. Spain received the highest number of students on Erasmus student mobility in all academic years, both in study abroad and placements, except France which received the highest number of students on placements. There has been an every year increase in all Erasmus actions. The UK continued to be the most popular destination in all academic years with a 45,7% increase in 2008./09. and 8,14% in 2009./10. compared to previous years. The most popular destination in all academic years for Erasmus staff mobility was Germany. In 2008./09. there has been an increase of 8,83% and in 2009./10. 1,2% decrease compared to previous year. As in staff mobility Germany was the most popular destination country for teaching assignments. There has been a unnoticeable 1,5 % decrease in 2008./09. and in 2009./10. an increase of 1,5 %. The most popular destination for staff training was the UK. Italy received the highest number of EILC participating teachers in all academic years. In 2008./09. there has been an increase of 36,4% but in 2009./10. there has been a decrease of 29%. In Erasmus Intensive Programmes data are available only for 2009./10. Italy was the most successful country. It received the highest number of students as teaching staff. Germany was the country with the most preparatory visits in 2007/08. In 2008./2009 most preparatory visits were organized to Bulgaria. There has been an increase of 15,3%. In 2009./2010 Turkey hosted the highest number of preparatory visits with 43,5% increase compared to previous year. The most popular destination for students is undoubtedly Spain and for staff Germany and UK. For EILC and Erasmus Intensive Programmes it is Italy. Only Erasmus Preparatory Visits has various countries.

4. Conclusion

Mobility of people in higher education of today has a clear role. These processes take place mainly at the level of individuals but also have an enormous impact on whole educational system. Every year more and more students as teaching and non-teaching staff are participating and Erasmus is becoming more and more popular. Over the years over 2 million students have participated in the programme. They covered nine tenths of the European universities and over thirty countries. This number rises every year. All countries need to invest more to improve the quality of education and training at all levels. For most the European countries, participation in Erasmus has contributed in many ways. It is therefore important to broaden cooperation as well as opening up and modernizing all higher education institutions and to increase number of participants in countries that until now didn't have recorder a major move.

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THE ORGANISATION OF THE EUROPEAN VOLLEYBALL LEAGUE IN SLAVONSKI BROD AND MARKETING ASPECTS

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Abstract
The aim of this paper is to demonstrate the possibilities and the application of sports marketing as an essential tool and segment in planning and realization of sports competition organisation, such as European volleyball league in Slavonski Brod. Apart from the theoretical approach, this paper also shows, through practical examples, the significance of marketing activities in the sports events organisation system for sports events organizers, for active participants of competitions and also for spectators who exchanged the sports product with their counterparts. Sports product in this paper, is defined as a key element of marketing which in this example, was the sports competition. From the birth to the execution of an idea, it is necessary to plan a series of activities for which the goals will be set, to realize them and in the end, to analyse the possibility of accomplishing those goals.

Keywords: marketing, marketing activities, sports product

1. Introduction

Sport is the need and the privilege of every human and an ideal instrument for learning the essential life skills [1]. In accordance with that definition, the significance of organized sport, which was nourished in ancient Greek, Chinese and Egyptian culture, has finally led to sport as we know it today – an industry composed of a massive spectre of sports competitions that vary on the scale from local to global proportions. Jago and Shaw defined the sports competition as a special event of high prestige, which attracts large groups of people and great media attention, requires substantial financial investments and is appealing to the hosts region. Furthermore, it serves as a tool for joining the offer and demand of various services and it leaves a certain heritage [2]. The afore-mentioned definition is a link that shares the joy of a sports consumer with the sport, the economy and the industry, and the contentment of those interests represents the activities of sports marketing.

Marketing in the sports competition system, is an instrument that is used for transferring the financial burden of hosting a sports event onto the sports consumers, in this case onto the spectators in Slavonski Brod, which are typical sports fans. Sporting event is a show always unrepeatable, special and unique. Not one sports event is self-consistent; it is comprised of a series of planning procedures and execution of all the necessary steps that are essential for its actualization.

2. Competition organisation

Planning of an event is a process that takes place in a period from the birth of an idea of organising a competition. It consists of making a business project that involves several crucial steps [2]. Goals: it is necessary to determine why this competition should be held, what can be accomplished by it, what are its benefits and how those benefits can be achieved; are there any political, socially-cultural, infrastructural, economic and/or sports advantages and in what time frame can they be achieved [2].

The main goal of organizing the European league was the popularization of volleyball in Slavonski Brod and Brod–Posavina County. But the volleyball club found itself in a difficult financial situation after the end of the season, so the secondary goal of organizing this kind of competition is defined as an opportunity for acquiring profit which is essential for keeping the club active in the coming seasons.

The concept of the competition realization: it is consisted of defining the structure of competition execution and determining how the competition should be realized. It is also important to take into regard the range and the significance of the event, the time period of its realization, the location and the place of holding the event, needed and available facilities, the targeted market etc. The analysis of sports event feasibility: it is necessary to make an outline of the business project which is in accordance with the beforehand defined goals. It is necessary to define the resources (physical, financial and human) and the conditions for realizing the project. One of the most important actions during this phase, but also during the whole process of making the business project, is calculating the profitability that proves the economic and social justification of organizing a sports competition [3]. Decision making [2]: by defining all the goals, the physical, the financial and human resources, by doing certain analyses in order to avoid mistakes (that occur in practice) in advance; you get results basis on which can be determined if it is possible to successfully organize a big sports event in Slavonski Brod. The competition management is consisted of an honourable committee that is comprised of the most significant people from organizational and socially-political structures and their task was to ensure the financial resources. The afore-mentioned approach has surely boosted the importance and the rating of the competition, and therefore it was of crucial significance for the competition in the period of making strategic decisions. The organization committee: one the basic tasks was to make key operative strategies in capacitating the needed infrastructure (facilities, equipment etc.), transport, accommodation, quality competition conditions, security etc. The executive committee: it was the heart of the organization and it was under the organization committee's jurisdiction. Its assignment was to directly conduct all the decisions and set tasks. The executive committee of the European league in Slavonski Brod had 5 members. The small number of members resulted in overburdening each particular member. Each member took care of multiple organizational segments. But owing to the devotion of the members, all of the assignments were realized in the given deadlines. The key segments of the sports competition organization that affect the creation of positive or negative attitude of all the participants (competitors, high officials, the media, spectators), besides the organization of the competition itself are: transport, accommodation, quality competition conditions, competition security, the media (press and TV), accreditation centre, volunteers, organizers' offices. There are two sources when sports financing in general is mentioned: budget (public) means and non-budget (specific) means. A mixed model of the two types of financing is the most common one in practice [3]. The European volleyball league in Slavonski Brod is financed with the mixed model of financing.

3. The marketing aspects of the competition

Sports marketing is a social process in which the individuals and the society get what they need and what they want by applying the marketing concepts and with the help of a number of activities that enable the exchange of sports products and services in the market [4].

In the case of the European league in Slavonski Brod, the exchange consisted of the organisers and active participants of the competition (players, coaches) that have exchanged the sports product with the counterpart – the spectators.

A marketing mix was made with the aim of recognizing the sport from a marketing aspect as a product, by considering the factors that affect the valorisation of the sports event and its image, by stating the arguments that indicate to understanding and comprehending the sports competition as a product and a media, and as a contemporary means of market communication [5]. The product: a critical element of the marketing mix and in this example, it is the sports competition. There is a possibility here for the application of the concept of sports marketing for sports as a product, treating the mere factors of sports events as a market for sports – industry products. During the making of a marketing plan, the sports product had been attempted to be defined in the mentioned example. It is also essential to define whether a sports result can be marketed as a product, does it have its buyer and what is the demand for a sports result in the Slavonski Brod market. The elements of the sports product that had been attempted to be used in the case of the European league organisation: the service of watching the sports competition which is intangible and unique; the sports event that is the sports product by itself; a mutual buying-selling relationship or a bought ticket; a wide range sports auditorium, a mass media character; television coverage; potential advertisers through a process of representing themselves on a potential market. It is important to also mention the factors that dictate the visitation rate of a sports event and they are: the suspense and the tension, attractiveness, the quality of the rivals and the event, a quality marketing approach. The needs and the privileges of attending the competition were ensured by marketing activities, for the sports consumers and spectators in Slavonski Brod, which are typical sports fans. Needs: to be excited and thrilled, to be a part of the group and to fill their free time. The privileges: the thrill of the game itself, rivalry with the opposing fans, other commodities that the sports facility has to offer. Marketing activities through which the organiser tried to accomplish the goals: the price which in this case represents the value of the sports product and significantly affects the profitability [4]. The basic elements used for determining: usage of the sports facility, equipment, aiding tools and specific surface, financial means for athletes' preparation, other program participants and the market value of the competition. Distribution consists of activities that ensure the flow of goods and services from producer to consumer. The primary goal of distribution in this case was to offer the sport product through various activities. The organiser had to devise a plan for the distribution of promotional material on places with high visitation rate, like shopping malls, volleyball clubs etc. Tickets and shirts with European league logotypes were sold. The price of the ticket for one game was 10,00 kn and the price of the shirt was 50,00 kn a piece. Promotion is the communication with the consumers, getting them acquainted with the product. A good promotion before and during the sports competition is one of the key elements for success. The shirts were given for free if a person buys tickets for four games. The promotion in general was joined by the women volleyball team, which the visitors used as an opportunity to take photographs and also promote the competition in that manner. Propaganda, a paid form of representing that is transported to the targeted group by media [6]. The billboard on Slavonski Brod's main square was also used for promotional purposes. A quality presentation of the coming events was provided by setting up a jumbo banner on such an attractive location. The promotional activities for the European league started months before the start of the competition, through personal promotion by holding press conferences where the organisers would state the significance and the aim of the European league organisation. Besides the promotional material, the plan must also contain the strategy of advertising which includes a direct marketing, namely local and regional newspapers, television and advertising at the event location. The aim was to make people aware of the coming event and to provide exposure to local partners and official sponsors. Slavonsko-brodska TV and Radio Brod had daily announcements in their programme for European league games, but also gave tickets and shirts. The publicity, which is an unpaid form of promotion and is more valuable than propaganda, was accomplished in cooperation with Moto club “Brod”. They organised a motorcycle entourage for the teams to the SD “Vijuš” sports facility. Two motorcycle groups welcomed the teams in front of their hotels and then escorted them to the sports facility. The motorcyclists and the teams' buses both had police escort. Besides a great interest of passer bys, the guests' impressions were very positive. Public relations, knowing the role and the meaning of using the advanced instruments of PR, were also represented in the marketing plan through continuous representation: public appearances, publicity in order to ensure a sufficient number of spectators during the competition, but also in order to attract the maximum attention of the media. Then there is maintaining a positive attitude. During the games, a shirt giveaway was organised. In order to induce a greater and louder support from the spectators, shirts were given to the loudest ones. The interaction with the spectators was achieved by throwing the ball in their direction on the stands. The spectator that would catch the ball would get a gift package from the sponsors.

4. The effects of the European league organisation in Slavonski Brod

The positive effects of the European league organisation are manifested in the successful organisation of the whole competition and its long term legacy. Looking from a marketing aspect, the main goal was achieved, and that is the popularization of volleyball in Slavonski Brod and Brod-Posavina County [7]. Different age groups, motivated by this event, have started to show interest in the clubs activities and volleyball, in general. Besides the increased number of registered members of volleyball school, there are more and more recreational volleyball teams that now have their own amateur league on a local level. From a socially – political aspect, a quality promotion of the town of Slavonski Brod and Brod-Posavina County was also achieved which was partially helped with teams' receptions at the mayor's and county prefect's offices. They showed their appreciation for hosting such important event by attending the games. During the competition, about 200 guests resided in different town accommodations, which resulted in a good occupancy of the accommodation capacity. Slavonski Brod presented itself as an extraordinary host and as a town with a great tourist potential.
The club didn't accomplish its secondary, namely financial goal and therefore wasn't able to use the opportunity for acquiring profit which is essential for club's functioning in the coming seasons. Organizing the European league didn't succeed in the role of a generator of positive economic effects for the club. On the contrary, it caused some unexpected costs, but also misunderstandings with certain sponsors that didn't pay the agreed amounts. Because of the negative financial result, ŽOK “Marsonia” wasn't able to settle its obligations.

5. Conclusion

The paper shows and clarifies the structure of the organisation of the European league in Slavonski Brod, especially from a marketing aspect. The main aim of this paper is to show the marketing tool, the way it functions, its advantages, but also to show which parameters should be observed when organizing this kind of sports competition. During planning, the organiser has to set realistic and adequate goals that should be achieved when organizing a sports competition. It is also necessary to determine a clear vision with a quality management, a mission and a strategy of entering the market, but also to economically and socially justify initiating such a project. If the conditions for accomplishing the set goals are still present after the necessary analysis, the organisation preparations can start. The organizers of the European volleyball league in Slavonski Brod have set two goals: popularization of volleyball in Slavonski Brod and acquiring profit. The goals were planned to be achieved by the sports product exchange which in this case, was the sports competition. The sports product in this paper is defined as a key element of marketing. The most important elements of the sports product that were attempted to be used as a marketing tool in the example of organizing a European volleyball league were: the service of watching a high quality sports competition (not many examples in Slavonski Brod); a sports event (as such, it has multiple consumers); attractiveness, suspense and the tension that a high quality sport can offer.

A well conducted promotion of the sports product, namely the competition, through a set of the mentioned activities, affordable price and a quality distribution of the product, have attracted a large number of sports consumers to the competition. Those are the key elements to success of applying the marketing concept in the area of sports. The results of that can be seen in the fact that the European league left a significant mark in Slavonski Brod. Slavonski Brod was exposed in the media and it was presented to a broader public as a good host. The guests got in touch with the culture, the tradition and the sights of a town from which they left with some nice memories. It was also a great honour for the volleyball club to be a host to such a big competition that through marketing (defined by a sports product), in its main goal resulted in attracting a large number of new members in the volleyball school. Unfortunately, the European league brought financial problems for the club that left a mark on the sports results in the next period. The executive committee of the competition consisted of only five members whose tasks were very demanding and required their full devotion. Thanks to their devoted work, the conditions of the competition were quality worthy. The financing presented a big problem for the organizers. Significant oversights occurred during the planning of this segment, which resulted in a negative financial result. Some of the sponsors that were promoted on the banners, the posters, the tickets, even on the court itself, haven't paid the agreed amounts. In order to prevent these kinds of faults in the future, it is necessary to define the rules of sponsorships more clearly. From the moment a sponsor pays the agreed amount of money, it is considered an official sponsor of the competition. The organizers' assignments in Croatian sports are usually done by managers of different expert profiles. Sports managers have to be experts that have acquired their knowledge, skills of managing and other abilities through education and experience in a particular sport. In contemporary Croatian sport, that level of expertise, according to statistics available in literature, has been reached only in certain areas of sports business.

Note: This paper is result of a final thesis of former student at the University of Applied Sciences of Slavonski Brod.

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RESOURCES FOR INCREASING MANAGEMENT PERFORMANCE AND EFFICIENCY

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Abstract
The aim of the paper is refer to resources how to increase management performance and efficiency in field of industrial companies. We try to refer to opportunities which could be useful and applicable and should lead to performance improvement. The paper also discusses about factors effecting organizational and management efficiency.
Keywords:
Management, performance, efficiency, motivation, social climate, ergonomics

1. Introduction

We live in a time that is very dynamic. The current dynamics of business environment causes that the management must focus on performance and efficiency of corporations at all levels – it is based primarily on corporate strategy. Success and business performance increases proportionally with the willingness and ability to lead companies, to know business wealth generating activities such that they should operate effectively and such to take quality decisions which will have benefits for customers and also help in fulfilment of corporate goals[1]. Increasing business performance can be achieved by consistent orientation to: motivation for improved performance, ergonomics and working environment, social climate and managing organizational performance.

2. Organizational performance and efficiency

Every corporation has determined goals. To fulfil this target setting they need to find adequate personnel on the labour market. This is the reason, why it is necessary for all corporations to ensure employees who will supply desired power and contribute to the achievement of business goals.
Job performance refers to the degree of the tasks generating the job, means not only the quantity and quality of work, work behaviour and other characteristics considered important in the context of performed work [2].
According to Wagnerová job performance indicates the result of work activities performed at certain times and under certain conditions [3]. Other work performance concept says that it is a prerequisite performance; in other words, performance is "the ability to submit power" [4]. Many authors concerned with the issue of job performance (efficiency) the two concepts are often confused, take them as synonyms and in most cases speak of the "work performance" [5].
Performance management (PM) includes activities that ensure that goals are consistently being met in an effective and efficient manner.
Work performance management combines improvement of individual job performance, team performance and organizational performance, development of employees work skills and their adaptation to the value of employer [2].

3. Factors affecting performance and efficiency

The term efficiency means the maximum achievable job performance, or ideal desired power. In the performance of tasks human normally applies only a part of their potential output, so there is a remaining power reserve which allows full regeneration of work force [6]. In addition, human performance is affected by other factors:

- Motivation for improved performance
- Ergonomics and working environment
- Social climate
- Performance management and its evaluation

Figure 1. Selected areas influencing management efficiency

4. Motivation for improved performance

The ability of humans to create useful outputs and be efficient in terms of the company depends on the quality of the corporate work organization, from the knowledge, skills for the job and the quality of working environment. When these factors met determining importance for human performance is the degree of motivation. The organization can be powerful in a long term only if employees are able and motivated [7].

Motivation can inspire, encourage, and stimulate individuals and teams to achieve great accomplishments. Motivation can also create an environment that fosters teamwork and collective initiatives to reach common goals or objectives [8]. It is the combination of a person's desire and energy directed at achieving a goal. Motivation can be intrinsic, such as satisfaction and feelings of achievement; or extrinsic, such as rewards, punishment, and goal obtainment. The biggest motivational mistake is to think, that „*all people are motivated by the same thing*“ [9].

Throughout the study and application of motivation, managers must know what motivates each team member. The encouraging impact of a human needs analysis provides the manager with the ability to understand what teams and individuals desire most from their work and allow an ability to uncover the variety of basic human needs and motivators to improve collective performance [8].

5. Ergonomics and working environment

Ergonomics deals with the comprehensive concept and designing work environment and health with the aim of reducing the human effort to increase efficiency and effectiveness. The benefits are proven in the form of pleasant feeling from work, increasing work performance, and reducing errors. The results of the application of ergonomics knowledge are reflected in higher quality of work environment, higher productivity, increased efficiency, satisfaction, and welfare at work and after work.

In view of working conditions provision the corresponding ergonomic directives are especially considered in the following:

- lighting,
- colour treatment,
- noise level,
- microclimatic conditions.

Lighting of the working environment directly determines:

- process, the quality and quantity of the performed work,
- psychological readiness of employee to give the best performance.

To avoid the negative effects of lighting, there should be worked-out an optimal light regime for each workplace.

Colours affect the perception of space, length, height and distance, distinguishing objects, feeling hot and cold (warm colours – active and dynamic; cool – relaxation), as well as emotional atonement of a man at the moment.

Noise in the work environment does cause harmful interference, make people nervous, makes the communication difficult, and causes also loss of concentration, and increased error rate.

Microclimatic conditions defined by the subjective feeling of being well or unwell, can be considered in extreme cases as harmful pollutants with adverse effects to human health. These are mainly:

- air temperature (unsuitable temperature conditions in the workplace adversely affect thermoregulatory processes of the employee, which also affects psychological processes),
- humidity and air flow – the draft may be sensed by the staff as a negative experience,
- smell or odour in the workplace (may initiate sympathy or antipathy).

6. Social climate

“Pleasant working environment, young and dynamic collective and an opportunity for personal growth...” These are formulas such the employers are generally characterize a group of people who works for them. Sometimes it's really true, at another times behind these words are hiding another meanings. It must be noted that the conditions for fair employment relationships or working collective are created by all teammates, colleagues.

Correct working and interpersonal relationships creates a productive climate, which has a very positive impact on individual, team and company-wide performance. Relations (employer, employee, unions, associations, customers, public, teams) have a formal and informal aspect. The side effects of relations are conflicts, which are a common cause of human resources work and style of leading people in the company. Effective tool of conflict prevention and creation of healthy working relationships is working system of communication [10].

In a world of globalization and rapidly changing technologies that control the world and all organization are working without national and cultural borders, trying to achieve and maintain market leadership. Managers must motivate people with very different cultural background, experiences and leadership style and cooperate effectively through time zones. If the multicultural teams are correctly developed, they can significantly contribute to growth and success of the organization. We may note therefore, that global teams with culturally different members – managers could be the most permanent source of competitive advantage for any company. Many studies show that this diversity of human capital really leads to increased creativity and work efficiency [11].

7. Performance management and its evaluation

Performance management is a process of evaluating progress toward achieving predetermined goals. In the field of human resources is used to maximize the performance of human resources and there through helping businesses to achieve strategic goals.

From the perspective of ensuring the stability of company, that is to say ability to respond to changing conditions and ability to actively influence their environment, are an essential factor possessing an undeniable impact on the performance of people – staff of the company.

The concept of work performance management is featured an effective performance management staff in order to achieve the total business performance. This is a connection of the overall performance with the performance of individuals and teams, with emphasis on employee performance so that most contributes to the aims of the organization.

The principle of work performance management in relation to overall corporate performance is knowledge of links between the indicators of job performance and business strategy. This should be evident not just for the top management but also for the employees, who are able to identify their contribution to the fulfilment of business performance [1].

Importance of evaluation of job performance consists in the fact that the company management has got detailed information about its employees, which allows better planning of their mobility, should guide their professional development and performance as well as proper use of their working and creative potential [12].

8. Conclusion

We live in a time, when the global economic crisis still persist and influence the course of most large companies. That's why almost every day talking about the performance and efficiency of companies respectively efficiency of its managers, who stands behind the success of companies. Successful enterprises reach for all the possibilities of improving the performance of their managers. A suitable combination of the above sources contributes as much as possible to increase the creative potential and performance of all managers.

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CUSTOMER RELATIONSHIP MANAGEMENT; DIFFERENCES BETWEEN THEORY AND PRACTICE

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Abstract
The main aim of the paper is to describe the differences between theory and practice in the field of customer relationship management (CRM). We would like to point out which kind of concepts theory prefers and what is the true reality that is reflected in practice. The best for theory and also for practice is to find problems in practice describe them and bring solutions. These two views on the issue of CRM should be linked together and not different, as it works now.
Keywords:
Customer, relationship, management, theory, practice, system

1. Introduction
In today's highly competitive world, enterprises are increasingly aware that it is important to focus on customers and their needs. Theory compares two principles: customer centric and product centric. Enterprises, that prefer a product centric approach are a rarity in today's market, or provide such inimitable product and have a monopoly on the market. The other enterprises have to “fight” for the new and also existing customers.
The customer relationship management (CRM) is based on strengthening customer relationships through reliable high-quality interactions and the effective implementation of commitments by using the most appropriate facilities [1].

2. CRM - Theory
Theory defines CRM as a number of strategies and technologies which are used to build stronger relationships between enterprises and their customers. An enterprise will store information that is related to their customers, and they will spend time analysing it, so it can be used for this purpose. We can say that CRM is built on four main pillars [2]:

- People - the knowledge and skills of employees is the ability to meet customer needs. Unskilled employees can hurt not only customers, but also directly to the enterprise,
- Technologies – tools (information technology) that enable the application of modern customer relationship management and a large number of customers. Technologies allow sharing of data about customers and their simple search, sorting and analysis,
- Processes - good function processes streamline the CRM,
- Data - information necessary to know about the customers. For the successful running of a business is necessary to know when and what the customer wishes and in the right moment to meet him his wish. The data are necessary to updated regularly. It is not enough just to have enough information, but it is important to provide further relevant information to the competent employee who is in contact with customers so that they can use it at the appropriate time. Not only to collect data, but also the possibility of retaining the accumulated data, retrieval and analysis of sorting according to lead to full-fledged customer relationship management [2].

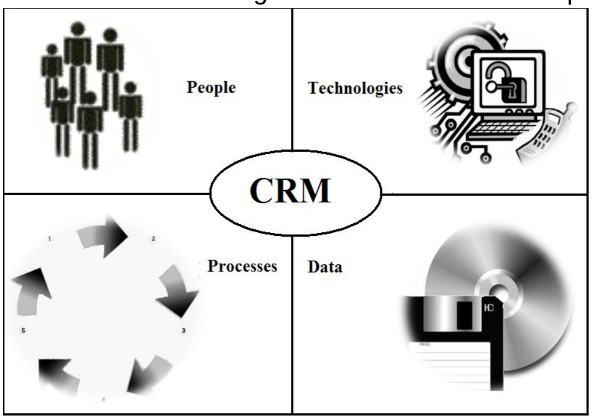

Figure 1. Main pillars of CRM

These pillars have to work together and if one of them is not enough strong, whole CRM do not work correctly. CRM pillars are very important also for practice. Especially main role plays people, because people actions influence all the other pillars.Customer relationship management is the "philosophy" of enterprise, which helps to improve customer interactions, to build and improve relationships with customers and thus increase competitiveness [1].
CRM is not a fad. It is an underlying principle of interacting with customers or clients, and it is something that all enterprises should practice. All executives need to understand CRM as a corporate strategy. Customer relationship management helps enterprises to gain an insight into the behavior of their customers and modify their business operations to ensure that customers

are served in the best possible way. In essence, CRM helps a enterprises to recognize the value of its customers and to capitalize on improved customer relations [3].

3. CRM - Practice

Comparing situation with CRM in western states of the European Union and CRM in the Slovakia, we find out that in Slovakia CRM is obviously lagging. The most commonly is CRM used in trade and services, telecommunications, and very notably absent in the factories.

The following studies of the experience of various professionals who deals with customer relationship management, presents reasons why customer relationship management is so important in all spheres of business and also highlight the usage and errors in the use of CRM.

1.) Kašuba, experts in the customer relationship management provides the following facts [4]:

- acquire a new customer is 5-10 times more expensive than maintaining the existing,
- company loses annually 10-30% of its customers in average,
- reduce the number of customers leaving a 5% increase in profit can bring up to 85%,
- 68% of customers leave indifferent approach to business, and only 14% for dissatisfaction with products and services.

These facts illustrate how important it is to know the business, deal with customers and manage customer relationships.

2.) Another survey was prepared at the Faculty of Business Management, University of Economics in Bratislava in 2007. Survey deals with terms of marketing research experience in Slovak enterprises as well as implementation of customer relationship management in enterprises [5]. The application of CRM survey revealed the following results [5]:

- 34, 3% of enterprises use customer contact manager,
- 13.7% reported having a CRM system,
- 11, 8% of the declared use of call centers, businesses that are not considered CRM system,
- 7.8% reported having a comprehensive customer contact center, CRM system that integrates with the modern call center.

3.) The third survey was developed by Vit Chlebovský in the Czech and Slovak Republic in 2005. Survey was focused on the perception and usage of customer relationship management in different types of businesses (small, medium, large, manufacturing, trading, providing services) with different numbers of clients. The survey involved 16 companies including 8 production, 5 providing services and 3 businesses, in size 8 medium-sized enterprises, 5 large and 3 small businesses [3].

Managers have to give the perception of CRM in a broader context [3]:

- 6, 25% said they understand the functionality of customer relationship management,
- 68.75% understands customer relationship management software as an application,
- 25% perceive customer relationship management in a broader context.

The use of CRM in the enterprise survey described as follows [3]:

- 37.5% does not use customer relationship management,
- 56.25% using customer relationship management limited, not completely,
- 6, 25% use customer relationship management.

The level of CRM in Slovak companies was analyzed by the Ing. Ľuboslava Novotna, PhD. In eastern Slovakia, empirical research was conducted on a sample of 261 firms in 13 industries in the industrial and services relating to the detection levels of Slovak companies in the CRM, with a focus on knowledge and level of customer relationship management. Empirical research has found the following facts.

Confirmed the high degree of customer orientation [6]:

- the lack of sufficient information about customers,
- no provision is made for internal information sharing,
- is not fixed responsibility for producing record after each contact with customers,
- top management does not pay enough time and space-related problems with customers,
- managers do not require the analysis of customers by profitability,
- the objectives are rarely evaluated in a quantitative way according to specific customers.

Another research was conducted at the University of Žilina led by William Lendel. Implementation of research on a sample of 73 companies operating mainly in the Žilina region was diagnosed level of Slovak companies on CRM, focusing on issues of knowledge and level of customer relationship management. Generally speaking, the average level of knowledge, with a sense of neglected essential points and details of CRM, companies that bring success in other European Union countries and USA. Understanding the principle of CRM correctly shows only 21% of surveyed companies, which agrees with the view that it is a shift in corporate strategy and customer needs. Most companies surveyed (63%) understands CRM as a service to customers, providing information to traders (10%) or the area of information technology (5%). [7]

According to the present research and experiences from practice we find out these main findings about CRM:
Enterprises are familiar with CRM, but only few of them also use CRM,
Customer satisfaction survey in enterprises,
Small number of enterprises use for customer relationship management CRM software systems,
Performance targets are rarely evaluated in a quantitative way according to concrete customers,
Level of CRM is based on industry in which the enterprise operates and also it´s based on ownership structure of the enterprises,
Situation with CRM utilization in industrial enterprises in Slovakia and Hungary is very similar,
Competencies for customer relationship management are divided among several departments in enterprises.
Top management does not pay enough time and space for customer related problems.
Organization place their customers to the hands of entry level employers, these employers are poorly trained poorly paid and also on the other hand poorly motivated.

8. Conclusion

The corporation modification to become customer-centric while still expanding revenue and profit is one of the hottest strategies in business today. The customer relationship management (CRM) is based on strengthening customer relationships through reliable high-quality interactions and the effective implementation of commitments by using the most appropriate facilities. The dynamic market, competition, changing of customer needs and rapid development of information technologies creates opportunities for the benefit of new and effective tools to bring companies more profit. Customer Relationship Management has rapidly become one of the leading competitive business strategies in the new millennium. CRM is about managerial efforts to manage business interactions with customers. CRM systems offer a combination of these tools, the latest IT technology and marketing philosophy [1].

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THE CONCEPTUALIZATION OF MATHEMATICAL NOTIONS IN TECHNICAL DISCIPLINES

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Abstract
The objective of this paper is to discuss the different way of presenting basic notions in calculus, such as limits, infinity and asymptotes, for the university students of technical disciplines. Vergnaud's Theory of Conceptual Fields is used to examine the development of student's schemes.

Keywords:
Conceptual field theory, operational invariants, theorems-in-action, asymptotes, WinPlot.

1. Introduction

Calculus is an important tool for building mathematical models in a lot of disciplines, such as physics, mechanics and economics. The main problem in understanding and manipulating some mathematical notions is that the mathematical concept is not correctly understood but its manipulation is acceptable or the concept is understood but it isn't adequately manipulated. The present study is a research on conceptualization processes of students faced with specific calculus tasks.

The main theory used as reference is Theory of Conceptual Fields of Gérard Vergnaud. Conceptual field is a set of situations for which solving processes imply schemes, concepts and theorems in tight connection as well as language and symbolic representations, likely to be used for representing them [1].

Theory of Conceptual Fields considers any concept to be a triple of three sets, $C = (S, I, R)$:

S - the set of situations which give meaning to the concept;

I - the set of invariants on which the operationality of the schemes is based;

R - the set of linguistic and non-linguistic forms which allow the concept, its properties, the situations and processing procedures to be represented symbolically [2].

Situations are responsible for the sense attributed to a particular concept [3]. The relation that the subject establishes when faced with a situation is mediated by schemes. The components of the schemes are anticipations of the objective, rules of action, operational invariants and possibility of inferences.

The operational invariants contained in the subject schemes are responsible for the meaning attributed to the situation and are completely based on the theorems-in-action and on the concepts-in-action. They guide the recognition of the elements belonging to the situation. The operational invariants imply the construction of stable objects of thought, which allow the construction the subject's rules of actions.

Theorems-in-action refers to the mathematical relations considered by students when they choose some concept to solve the given problem. These theorems are implicitly held by students and are generally not articulated. They cannot be called theorems in a traditional sense. They can have applications as they are used by students in problem solving but have lesser validity than conventional theorems. Sometimes they may even be wrong [6].

Denise Grenier presents different examples of conceptualization of some mathematical notions in her course of Theory of Conceptual Fields [7].

2. Method

24 participants in this study were students attending the first year of Bachelors degree at the Faculty of Materials Science and Technology of the Slovak University of Technology. Interrogate students followed the lessons of Mathematics 1. This calculus course is compulsory for all study programmes at the faculty. The objective of the course is to provide an understanding of solving algebraic equations, some basics of matrix calculation, limit calculation, evaluating limits using L'Hospital's rules and an understanding of differential and integral calculus.

We limit here our considerations to definitions of asymptotes in terms of limits. The objective of this didactic situation is to develop students' ability to use limits at infinity and infinite limits to determine asymptotes for the graph of a function and to show how the use of mathematical programs Maxima and Winplot in this course [5] help students in order to assist the understanding by providing an experimentation framework with visualization facilities.

Students were asked to find all vertical, horizontal and oblique asymptotes for the following function.

$$f(x) = \frac{x^3 + 2}{x^2 - 4} \tag{1}$$

The following general directions were presented to students.

- Draw the graph of this rational function in Winplot.
- Determine in which values make denominator zero, these values will be the *a*.
- Evaluate the one-sided limits at $x = a$ to find the vertical asymptotes. You can use the *find limit* command of Maxima.
- To find the other asymptotes $y = kx+q$, you need to find the following limits at infinity:

$$k = \lim_{x\to\pm\infty} \frac{f(x)}{x} \tag{2}$$

$$q = \lim_{x\to\pm\infty}(f(x) - kx) \tag{3}$$

You can use program Maxima to validate your calculations.

- Draw all asymptotes and make sure that your answers are consistent with the graph.

In what follows, we identify students' theorems-in-action and rules, which allow the generation of the subjects' sequence of actions and describe students' schemes in terms of operational invariants.

This is a qualitative research, in which we analyze the data obtained through observations and discussions with students during the didactic situation presented.

3. Results

Understanding the development of the concept of one-sided limits and limits at infinity suppose to situate in the conceptual field of Mathematical analysis. An individual's schemes of calculating a limit include goals, anticipations, rules of action, operational invariants and inference possibilities [4].

The theory of conceptual fields makes its possible to identify in these didactic situations the following concepts-in-action: domain of a function, left side limit, right side limit, infinity, vertical asymptote, oblique asymptote, equations of a straight lines, limit at infinity, indeterminate forms of limit, L'Hospital's rule.

The theorems-in-action that are taken by the students to evaluated the one-sided limits at $x = a$ are:

The limit of function f(x) as x approaches a from the right is $+\infty$ *.*

The limit of function f(x) as x approaches a from the left is $-\infty$ *.*

The easiest way to approach these one-sided limits is geometrically. A frequent strategy used by students was to estimate this one-sided limits numerically, then evaluate this limit in Maxima using *the find limit* command and finally to check it from a graph.

The following theorems-in-action have appeared in evaluating the limits of rational function at infinity:

The indeterminate limit's form $\frac{\infty}{\infty}$ *gives a numerical value 1.*

For evaluating the indeterminate limit's form $\frac{\infty}{\infty}$*, the quotient rule of differentiation will be use.*

The indeterminate limit's form $\infty - \infty$ *gives a numerical value 0.*

Many of students calculated this limits at infinity using algebraic simplification. The application of L'Hospital's rule was missing or if it appeared, students did not correctly use it.

Finally, students have drawn all asymptotes in program WinPlot and so visually make sure their answers.

It is important how these different components of the students' schemes can constitute indicators of the way in which they are constructing knowledge.

4. Conclusion

The theory of conceptual fields employed here provided a useful language to analyze how ideas, which the subjects have already connected up, are organized, and which concepts and theorems-in-action to solve problems students have followed. The conceptual field framework can be useful to help teachers in organizing their didactic situations that depend on better understanding of the conceptualizing process of students.

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A COMPARISON OF SCENARIO GENERATION METHODS WITH RISK-AVERSE DECISIONS

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Abstract
Different scenario generation methods are compared with risk-averse financial decision problems. Second-order stochastic dominance (SSD) can be used to formulate models involving random conditions, simulating risk-averse behaviour. Multivariate distributions can be well described by Copula functions, the models can be calibrated and according to the calibration random numbers are then generated. An analysis of the optimal results for dominance maximization problems is given. The data for this analysis is generated using various scenario generation methods: Copula functions and different one-dimensional generalized extreme value (GEV) distributions.

Keywords:
stochastic dominance, scenario generation

1. Introduction

SSD is a good choice for solving portfolio selection problems where risk-averse behaviour is essential for adequately modelling investor decision making. However, using SSD for solving this problem is computationally demanding because finding SSD efficient portfolios is a model having a number of infinite objectives.
For modelling the collective behaviour of random parameters we can use Copula functions. By applying this method we can separately consider the marginal behaviour of the random variables and the dependence between them.

2. Stochastic dominance

Let R and R' be random returns. Let Ω be a probability space with probability measure P and field of measurable sets $\mathcal{M}$. Let the random variables be integrable $R, R' \in \mathcal{L}^1 = \mathcal{L}^1(\Omega, \mathcal{M}, P)$.
Second-order stochastic dominance (SSD) can be defined by three equivalent conditions:

i. $E(U(R)) \geq E(U(R'))$ true where U is a concave nondecreasing utility function with existing finite expected values.

ii. $E([t-R]_+) \leq E([t-R']_+)$ true for $t \in \mathbb{R}$

iii. $Tail_\alpha(R) \geq Tail_\alpha(R')$ true for $0 < \alpha \leq 1$ and by $Tail_\alpha(R')$ shows the unconditional expectation of the least α percent of the outcomes of R.

In *(i.)* the concavity of the utility function marks the risk-averse behaviour. The equivalence of (*i.*) and (*ii.*) is shown in [1]. The equivalence of (*ii.*) and (*iii.*) can be found in [2]: here $Tail_\alpha(R)$ is considered a function of α, and $E([t-R]_+)$ a function of t. These functions are convex conjugates.
When (*i.*), (*ii.*) or (*iii.*) hold then we say that R dominates R' with respect to SSD, $R \geq_{SSD} R'$. The corresponding strict dominance is $R >_{SSD} R'$, meaning $R \geq_{SSD} R$ and $\neg\,(R' \geq_{SSD} R)$.

This paper focuses on portfolio returns. Let n be the number of investment assets at the beginning of a determined time period. By $\boldsymbol{x} = (x_1, \ldots, x_n) \in \mathbb{R}^n$ we denote a portfolio, the proportions of the portfolio value invested in the different assets.
$\boldsymbol{R}$ indicates the returns of the assets at end of the investment period. $\boldsymbol{R}$ is an n-dimensional random return vector. Our assumption is that the elements of $\boldsymbol{R}$ are in $\mathcal{L}^1$. If we consider $\boldsymbol{R}$ having realizations of different scenarios, then it can be described by a discrete distribution. Taking this assumption into account, the random return of an $\boldsymbol{x}$ portfolio can be defined by $R_{\boldsymbol{x}} = x_1R_1 + \ldots + x_nR_n$.
Let $X = \{x \in \mathbb{R}^n \mid x \geq 0, x_1 + \ldots + x_n = 1\}$ denote the set of feasible portfolios. We say a portfolio $\boldsymbol{x^*}$ is SSD-efficient if there is no feasible portfolio $\boldsymbol{x}$ for which $R_x >_{SSD} R_{x^*}$.
There are several SSD models we can review. We will examine two models, based on the SSd definitions (*ii.*) and (*iii.*).
Let us assume that a reference random return R_{ref} with discrete distribution is given. For example, this reference return could be the return of a benchmark portfolio or a stock index.

Using this reference return, Dentcheva and Ruszczyński [3] consider an SSD constrained portfolio optimization model according to the SSD definition (*ii.*):

$$\begin{aligned} &\max f(x) \\ &x \in X \\ &R_x \geq_{SSD} R_{ref} \end{aligned} \tag{1}$$

In the above model f is a concave function, specifically, $f(x) = E(R_x)$. The authors prove that when the random return vector has finite discrete distribution, the SSD relation can be defined by a finite system of inequalities. For the above assumption of finite discrete distributions, the

authors also develop a duality theory having the dual objects as concave nondecreasing utility functions.
Roman, Darby-Dowman and Mitra [4] describe a model according to definition (*iii.*). Here, they assume having finite discrete distributions with equally probable outcomes. It is proven that the SSD relation $R_x \geq_{SSD} R_{ref}$ can be described by a finite system of inequalities:

$$\mathrm{Tail}_{i/S}(\mathrm{R_x}) \geq \mathrm{Tail}_{i/S}(\mathrm{R_{ref}}), \forall\, \mathrm{i} = 1 \dots \mathrm{S} \tag{2}$$

In the above system *S* is the number of the equally probable scenarios. This model chooses an ***x*** portfolio whose return distribution R_x comes close to the reference return R_{ref} in a uniform sense. Uniformity is denoted by differences among tails. The *worst* tail difference is denoted by $\vartheta = min_{i=1\dots S}(Tail_{i/S}(R_x) - Tail_{i/S}(R_{ref}))$.
By maximizing ϑ we can consider the following multi-objective model whose Pareto optimal solutions are SSD efficient portfolios:

$$\begin{gathered}\max \vartheta \\ \vartheta \in \boldsymbol{R} \\ x \in X \\ \mathrm{Tail}_{i/S}(\mathrm{R_x}) \geq \mathrm{Tail}_{i/S}(\mathrm{R_{ref}}) + \vartheta \quad \forall\, \mathrm{i} = 1 \dots \mathrm{S}\end{gathered} \tag{3}$$

The origin of the above model can be traced back to [5] and [6].
It often occurs, that the used reference distribution is not SSD efficient. In these cases the model improves until SSD efficiency is attained.
The model (3) has been implemented and tested on 51 real-world assets with data from 710 realizations.

3. Scenario generation

For generating data for our model we used several scenario generation methods. The most complex method, using Copula functions has been chosen for modelling the collective behaviour of the random parameters. The other methods involve built-in distribution functions as the generalized extreme value (GEV) one-dimensional distributions. We also tried mirroring the GEV distribution in order to better fit our historical data. This distribution we called minGEV.

In this section we will focus on the Copula functions.
In [7] it is proven that given an *m*-dimensional distribution function *F* with marginal distribution functions $F_1, \dots F_m$, there exists a function $C: \mathbb{R}^m \rightarrow \mathbb{R}$ for which $F(z_1, \dots, z_m) = C(F_1(z_1), \dots, F_m(z_m))$, $z_1,\dots,z_m \in \mathbb{R}$. Additionally, if the marginal distribution functions $F_1, \dots, F_m$ are continuous then *C* is unique. The *C* function is called copula function.

In our analysis we used the Gaussian copula function:

$$\begin{gathered}C_\rho\big(F_1(z_1), \dots, F_m(z_m)\big) = \\ \Phi_{m,\rho}(\Phi^{-1}F_1(z_1), \dots, \Phi^{-1}F_m(z_m))\end{gathered} \tag{4}$$

having Φ the one-dimensional standard normal distribution function and $\Phi_{m,\rho}$ the *m*-dimensional normal distribution function with expectation vector **0** and correlation matrix ρ.
For calibrating the correlation matrix we used experimental marginals, using given historical data. Calibration was done using Spearman's rank correlation ρ^S as this correlation is preserved under monotonic transformations. There is a one-to-one mapping between the Spearman rank correlation coefficient and the linear correlation coefficient for bivariate normal random variables, that can be described by a formula. We used the inverse of this formula to compute the linear correlation matrix ρ from the Sperman's rank correlation matrix ρ^S.
Further details on the copula functions can be found in [8] and [9].

Samples of 60000 have been generated using the Gaussian copula and the GEV distributions.

Details of data generation can be found in Figures 1-3.

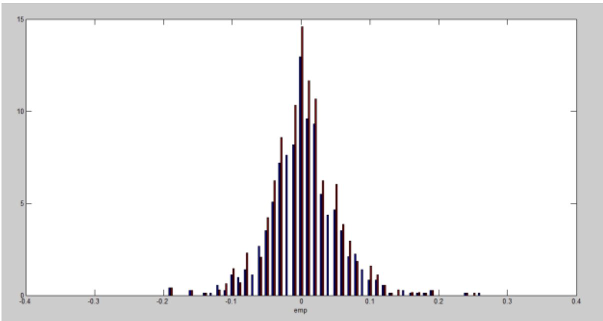
Figure 1. Data generated using the Gaussian copula

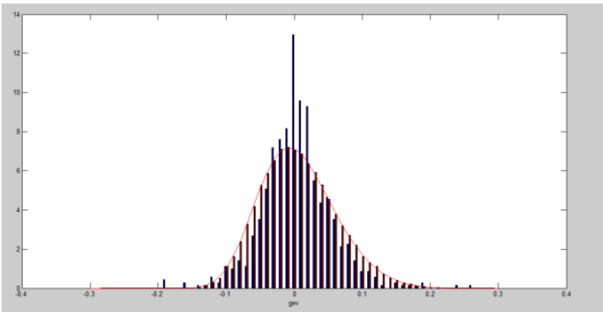
Figure 2. Data generated using GEV

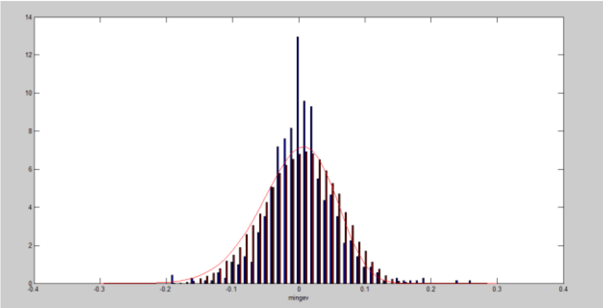

Figure 3. Data generated using minGEV

By blue we denoted the historical data while by red the distribution of generated data can be seen.
All three figures represent data of the first out of six independent data generations for stock number 2.

4. Computational study

The data set we used contains weekly returns of n=51 stocks and the index of the FTSE 100 basket. The historical data reaches 944 weeks.
For each week each component's price and the stock index is given. Let s_0^t represent the stock index of the tth week and let s_k^t be the price of the kth asset.
Each week's return is computed in the following way: $r_k^t := (s_k^t - s_k^{t-1}) / s_k^{t-1}$, $0 \leq k \leq n$. Let $\boldsymbol{r}^t := (r_0^t, r_1^t, \ldots, r_n^t)$ and the data set $\mathcal{R} := \{r^t \mid t = 1 \ldots 944\}$.
For creating a proper test set we divided the data set randomly into two subsets H and T. We used the set H for generating sample data and the set T for performing out of sample tests. Sizes of the subsets are 710 for the subset H and 236 for the subset T.
The division into subset has been repeated independently six times and for each set H we generated sample data using the empirical, the two types of GEV and the empirical methods.
For each generated set and each set H we compared the optimal portfolios. For each pair of sets in-sample and out-of-sample tests have been performed.
Consolidated in-sample and out-of-sample testing results can be seen in Figures 4. and 5.

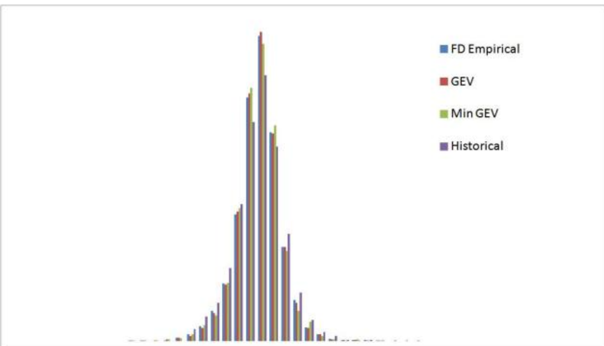

Figure 4. In-sample testing results

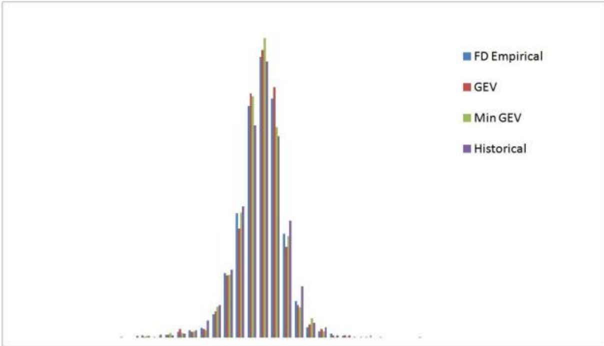

Figure 5. Out-of-sample testing results

Expected values and variance data can be seen in Tables 1 and 2.

Table 1. In-sample results

	E	σ
Empirical	0.01539	0.05868
GEV	0.01558	0.05340
minGEV	0.01388	0.05641
Historical	0.002449	0.02127

Table 2. Out-of-sample results

	E	σ
Empirical	0.00242	0.01972
GEV	0.00254	0.01954
minGEV	0.00225	0.01968
Historical	0.00245	0.02170

5. Conclusion

We performed analysis of different scenario generation methods for the financial decision problem of selecting the optimal portfolio. The data used for our decision has been generated using different scenario generation methods. We conclude that the marginal distributions used for generating sample data do not considerably influence the optimal return of the chosen portfolio. However, the index distribution was dominated in all cases by the distribution of the optimal portfolio.

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IMPACT OF MULTIPLE INTELLIGENCES ON LANGUAGE LEARNING

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Abstract
The importance of the idea of multiple intelligences in education lies in the fact that learners vary in their abilities, and thus teachers need to find out the best strategies to use related to their variations, or to develop programs that instruct students in different domains. A brief overview of the eight multiple intelligences connected with Howard Gardner's theory is presented in this paper. Some ways for teachers to incorporate the intelligences into their daily lesson planning for practical use in language teaching and learning are also suggested in this paper.

Keywords:
Multiple Intelligences, Language Learning, Classroom Activities

1. Introduction

Various theories on learning have been developed with increasing frequency in the last few decades. All learners are individuals with unique patterns of strengths and weaknesses. Furthermore, they differ greatly in cognitive abilities, particularly intelligence. The early theories about the nature of intelligence include one or more of the following components: (1) the capacity to learn, (2) the total knowledge a person has acquired, and (3) the ability to adapt successfully to new situations and the environment in general. However, intelligence is a broad concept which has generated controversy and heated debate [1], and no unified theory of intelligence has been proposed yet. Most commonly, people accept that a definition of intelligence is connected with a score on the traditional intelligence test, but these tests only measure one or two types of intelligence. The theory of Multiple Intelligences was developed in 1983 by Dr. Howard Gardner, professor of education at Harvard University, and it was first published in the book *Frames of Mind: The Theory of Multiple Intelligences*. Gardner points out in the book that human talents and intelligences are much more than the old I.Q. tests had shown. His theory challenges traditional views of intelligence. He [2] defines intelligence as "*the capacity to solve problems or to fashion that are valued in one or more cultural settings*". Gardner proposes a new, pluralistic, view of intelligence that has been widely embraced since its publication, and now it is incorporated in school curricula across the world.

In this paper, Multiple Intelligences (MI) in the foreign language classroom can help language teachers to give recognition to the holistic nature of learners and to address student diversity. This approach enables them to organize a variety of ways that increases the attractiveness of language learning tasks and therefore create favourable motivational conditions.

2. Multiple Intelligences Theory (MIT)

Howard Gardner's theory of Multiple Intelligences utilizes aspects of cognitive and developmental psychology, anthropology and sociology to explain the human intellect. By studying the effects on brain-damaged individuals, savants, prodigies, the learning disabled and the autistic, Gardner developed criteria for identifying several separate intelligences. He originally listed seven distinct intelligences based on skills and abilities valued within different cultures: linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal and intrapersonal in *Frames of Mind*. The first two have been associated with schools; the next three are more inclined towards art; and the final two are what Gardner labeled personal intelligences [3]. He added "naturalist" intelligence to this list at the symposium "MIND 97" (Multiple Intelligences New Directions) in 1997. However, the list of eight intelligences is not meant to be final and the point is not the exact number of intelligences but Gardner wanted to emphasize the plurality of mind [4].

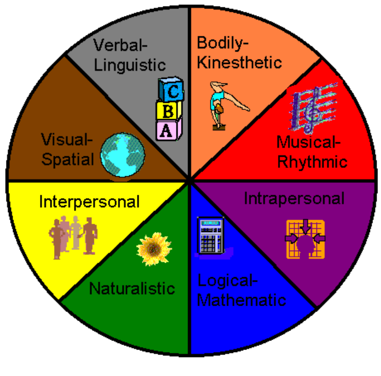

Figure 1: Eight Multiple Intelligences

Gardner wanted to make a clear distinction between an intelligence with its biological origins and a talent or skills. He identified some criteria that each intelligence must satisfy (at least majority of them) to be considered an intelligence. These criteria include brain damage studies, having a distinct development history, having roots in evolutionary history, psychometric findings, support from experimental psychological tasks, distinguishable set of core operations and susceptibility to encoding in a symbol system [2].
According to Gardner [3], all human beings possess all intelligences and the exact combination of intelligences varies from person to person. Each person has a unique intelligence profile. Different intelligences occupy different areas of the brain. Although the intelligences are separated from each other, Gardner claims that the eight intelligences very rarely work independently in a real-world setting [3]. Most tasks require the simultaneous use of several intelligences in order to be completed successfully. Some people can be strong in all or most of the eight intelligences; a few people lack most of the fundamental aspects of intelligence, but most people are somewhere in the middle having a few intelligences highly developed, most modestly developed and one or two underdeveloped [5]. Furthermore, Gardner suggests that anyone has the capacity to develop all eight intelligences to a reasonably high level of performance with appropriate encouragement and instruction [2].
Although the theory was not originally designed for use in a classroom, Gardner's research provides direction how to improve a student's ability in any intelligence and the teachers are encouraged to include a variety of the intelligences in a classroom.

3. Using Multiple Intelligences to Teach Foreign Languages

There has been quite a lot of discussion about the effectiveness of using multiple intelligences to teach foreign languages. Schools usually use logical and verbal intelligences to teach languages and the five non-traditional intelligences, spatial, musical, kinesthetic, interpersonal and intrapersonal, have generally been overlooked in education. However, if we can engage activities which require various intelligences, we will increase possibilities for student success. According to Richards and Rodgers "language is not seen as limited to a 'linguistics' perspective but encompasses all aspects of communication" [6]. MIT is a great tool to enable teachers to plan attractive ways to provide learners with language learning practice. The MIT instructional perspective proposes that language learning can be favoured by using different learning tasks which call upon diverse intelligences. All students will come into the classroom with different sets of developed intelligences. This means that each individual will have his/her own unique set of intellectual strengths and weaknesses. These sets determine how easy or difficult it is for a student to learn information when it is presented in a particular manner. The teacher offers a choice of tasks in order to give learners the opportunity of apprehending information in their preferred way, and to promote the development of their other intelligences.
Although our schools and culture pay more attention to linguistic and logical intelligence, it is necessary to provide several different ways in which materials might be presented to improve effective learning. It does not mean that we must teach or learn something in all eight ways, just see what the potential pathways and possibilities are, and then decide which ones seem to be the most effective teaching or learning tools. It is a good idea to give the students a Multiple Intelligences test to see which intelligences are outstanding for each student [7]. Armstrong [5] believes that before teachers apply a model of learning in the classroom, they should apply it to themselves as educators first. Therefore, the next step in helping teachers apply MI theory in the classroom is to help them determine their own multiple intelligence profile. Furthermore, teachers need to categorize familiar EFL (English as a Foreign Language) activities, to conduct a personal audit of teaching strategies and finally, to develop different assessment techniques that also address the eight intelligences [4]. As long as teachers use a broader range of various classroom activities according to the intelligences, there will always be a time during the day or week when students have their highly developed intelligence(s) actively involved in learning [8].
An overview of multiple intelligences and the way how these intelligences are involved in foreign language learning and teaching is given in this section. Descriptions are combined from several sources [8, 9, 10, 11, 12, 13, 14, 15].

• The Verbal-Linguistic Intelligence

The verbal-linguistic intelligence is the most universal of the eight intelligences. It represents the ability to use language masterfully to express oneself rhetorically or poetically in speech and writing. It includes the mastery of phonology, syntax, semantics and pragmatics. It also includes being able to use language for convincing others, understanding patterns of language, etc. This intelligence is traditionally tested in many standardized tests, as well as psychological tests. A great example of this type of foreign language learning is standard teacher centered learning. The teacher explains a learning objective and the students learn. The linguistic intelligence also involves classroom activities such as debates, group discussions, brainstorming, word games, writing activities, storytelling, telling jokes and riddles, translation exercises, publishing (e.g. creating class newspapers), sharing time, journal keeping, memorizing linguistic facts, tape recording one's words, etc. [8].

• The Logical-Mathematical Intelligence

The logical-mathematical intelligence represents the skill to use numbers effectively and reason well. This intelligence is involved in recognizing abstract patterns, making predictions, problem solving and scientific investigation. "This intelligence is often associated with what we call 'scientific thinking' " [10]. In the language classroom, problem-solving tasks are useful as learners focus mainly on meaning, but through constant rereading of the text to solve the problem, they acquire a familiarity with the vocabulary and structures used. As well as verbal-linguistic, this intelligence is mainly used in standardized tests. Armstrong [8] suggests creating codes, logic puzzles and games, classifications and categorizations and Campbell, Campbell and Dickinson [12] offer many great ideas such as diverse questioning strategies, posing open-ended problems, justifying or verifying statements or opinions, providing opportunities for observation and investigation, using technology to teach, learn and extend student understanding.

•The Musical-Rhythmic Intelligence

The musical-rhythmic intelligence involves the ability to perceive, understand, and express emotions and feelings through music showing "sensitivity to rhythm, pitch, and melody" [9]. In general, the development of musical intelligence in the language classroom can have benefits such as helping students to concentrate and connect with their inner self, stimulating creative processes, and fostering a relaxed but motivating and productive classroom atmosphere. It is essential to design some of following activities to develop learners' musical intelligence: background music, mood music, humming, whistling, linking old tunes with concepts [8], encouraging awareness of surrounded sounds, singing, using raps, jazz and chants to memory lesson, turning some parts of lessons into a song or rhythmic chant, choral reading, singing and speaking, etc. [11].

• The Visual-Spatial Intelligence

The visual-spatial intelligence involves "the sensitivity to form, space, colour, line and shape" [9]. This intelligence involves visualizing things either mentally or graphically. Visual elements are especially useful for providing comprehensible and meaningful input for second language learners. Many students also find that visual teaching aids such as charts, pictures, drawings, slides, posters, and videos enhance their coping ability in the second language. Any type of learning activity that asks students to interpret visual information can contribute to visual or spatial intelligence. Vocabulary trees are also a great example of using visual intelligence to improve vocabulary skills. Dung and Tuan [11] also suggest working on jigsaw puzzles and making mind maps and Armstrong [8] suggests imaginative storytelling, creative daydreaming, colour cueing, idea sketching, optical illusions and so on.

• The Bodily-Kinesthetic Intelligence

The bodily kinesthetic intelligence refers to the ability to use the body to express oneself, to handle physical objects dexterously. The body expresses what the mind harbours and vice versa [16]. The use of role-plays, drama, mimes, games, project work, shadow puppets, hands-on activities, body maps, tactile materials and experiences, crafts, and many activities related to group dynamics directly addresses the bodily-kinesthetic intelligence in the language classroom. This type of learning combines physical actions with linguistic responses. Campbell, Campbell and Dickinson [12] also highlight exercise breaks to help energize or calm down students.

• The Interpersonal-Intelligence

The interpersonal-intelligence is the ability to interact with people effectively, for instance, while working on a team, or being part of a community. It involves the ability to understand others, be sensitive to other people's feelings, moods, motivations, and behaviour [9]. Understanding other people, working cooperatively and communicating effectively, which are parts of the interpersonal intelligence, are strongly connected to learning a second language. Pair work, group discussion, peer sharing, group brainstorming sessions, simulations and peer teaching are some of the activities that can help to develop this kind of intelligence [8], as well as interviewing for knowledge and finding individuals with like interests [13].

• The Intrapersonal Intelligence

The intrapersonal intelligence or inner-self intelligence "involves the capacity to understand oneself, to have an effective working model of oneself – including one's own desires, fears, and capacities – and to use such information effectively in regulating one's own life" [3]. Language learning tasks such as asking learners to think of the colour, size, texture which best expresses their feelings, or the use of a questionnaire that helps them to be aware of their "self-talk" or reading activities where students develop their attitudes towards a problem are examples of how to work on the intrapersonal intelligence in the language classroom. Teachers can include the intrapersonal intelligence through some more activities such as journal keeping, self-esteem activities, goal settings, individualized projects and games, one minute reflection periods, self-paced instructions and so on [8].

• The Naturalist Intelligence

The naturalist intelligence involves the ability to "understand the natural world" [14] by recognizing, classifying and categorizing species found in nature such as plants, animals, and minerals [15]. Activities such as brainstorming on how to contaminate less, or describing the process of recycling paper, tasks involving direct field observation and classification of the vegetal and animal world, talking about pets and natural places or reading books, magazines and newspapers on the nature relate to the naturalist intelligence.

4. Conclusion

Schools have often tried to help students to develop sense of accomplishment and self-confidence. Gardner's Theory of Multiple Intelligences provides theoretical basis for recognizing the different abilities, skills and talents of students. Approaching and assessing learning in this manner allows a wider range of students to successfully participate in classroom learning. Organizing teaching with MI theory in mind provides lessons more individualized and tailored to students' specific learning needs and offers various teaching ideas that can increase students' interests and motivation in their studies and their higher level of engagement. Finally, students become intelligent learners able to understand and direct their own learning and development to achieve outstanding academic success.

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DEMANDS OF AUTOMOTIVE INDUSTRY ON KNOWLEDGE OF UNIVERSITY STUDENTS IN THE FIELD OF QUALITY ASSURANCE

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Abstract
In contemporary “flat” world we are almost every day literally massaged with news informing about problems resulting from poor quality products or services that affects our lives. Mentioning at least two significant and widely well known incidents the British Petrol oil spill in Gulf of Mexico in 2010 and Toyota recall campaign in 2009 calling over 9 000 000 defective vehicles, and finally the plethora of miscellaneous poor quality food products in the supermarkets. This is only the top of iceberg and situation in industry around the globe is even worse for most of the problems are hidden under the “surface”. The article deals with description of current state of quality and dependability management within industry, particularly in the automotive, discusses lecturing approach and proposes the changes in order to span the gap between industry demands and university program offers. Finally, responsible, quality oriented and skilled people can be prepared to satisfy the future demands for sustainable development of society.

Keywords:
Quality Assurance; Education; Management

1. Introduction

The very fast development of modern technologies accompanying with growing complexity and variety of machinery forces the producers and users into an implementation of systems that are effectively able to assure their flawless and reliable performance. Guaranteeing such parameters only the combination of quality design, quality production, and quality complex care during the whole machine lifespan can be the right way to attain the success. The Management of quality and reliability goes hand in hand with the sphere of machinery operation and complex machinery care. Present university graduates are relatively very well prepared with knowledge regarding machinery design as well as manufacturing technologies. On the other hand the level of operation and machinery exploitation knowledge is very poor and even missing even though this knowledge is crucial for technologists and managers as well. This statement can be confirmed by industrial quality results around the whole world [1, 2]. Contemporary trend the industrial sphere is focusing on is an implementation of principles and rules of management of quality and dependability into the field of maintenance thus the organization of maintenance and repairs, machinery operation, and quality performance of machines. Department of Mechanics and Machines at Faculty of Management and Production Technologies in Usti nad Labem focuses on above mentioned areas in its curriculum chiefly in three subjects the “Operation and Maintenance of Machines, Measurement and Technical Diagnostics, and Quality Management.

2. Contemporary situation in Quality Assurance within industry

However, the main principles of Quality Assurance are registered in ISO 9001:2000 and surely ought to be reflected in each company process the present state is vice versa. The main problem the companies facing nowadays is a deficiency of appreciation of these principles and the ability of their implementation into everyday life. This lack of knowledge is indicated not merely with main company processes but can be observable primarily at process interfaces. In the range of Quality Assurance the points at issue can be divided into three subgroups. The first one is a group of problems within the department of Quality Assurance; the second group of problems is on interface with other departments and inside of them, and finally it is the quality system itself. In many companies, within internal (suppliers and internal processes) and external quality, there is missing a knowledge of methods for supplier`s selection in a scope of production parts approval, and their consequential development and management. This situation leads to inconvenient mutual contracts with suppliers, when non-conform parts that cannot even be claimed are permanently supplied. Such non-conform manufacturing parts are regularly processed by production lines and then shipped to customers and afterwards frequently returned back in form of claims from the end users. The main effort with occurrence of non-conform parts is dedicated to “extinguish a fire” activities instead of focusing on prevention. This is associated with knowledge of analytical methods like FMEA (Failure Mode and Effect Analysis), FTA (Failure Tree Analysis), RCA (Root Cause Analysis), or TRIZ (Theory of Inventive Problem

Solving), which are not properly applied or missed in the case of machinery specifications, machinery preparation, and with problem solving during machinery operation. Without understanding and proper use of the mentioned methods it is almost impossible to accomplish the fundamental requirement “the decision based upon the facts” and it can be often seen that the important decisions are based on faulty hypothesis instead which leads to reoccurrence of the same problems over and over again. By influence of a number of factors like machine operational quality, operators performance quality, manufacturing and measurement methods, measurement equipment as well as the quality of manufacturing parts and devices with manufacturing processes a great deal of problems emerges. First problem is awareness about quality. The employees from production, maintenance, engineering, logistics, and production control do not understand the significance of quality assurance as the standard and crucial factor for success. Quality assurance is sometimes considered as a necessary evil. Such an understanding leads to disrespect and circumvention of procedures and standards as well as the indolence with root cost problem solving, and creation and implementation of action plans. The second problem is the non employment of system approach into company processes. The particular departments do not mutually cooperate and do not understand their mutual interconnection in terms of processes and operations, and the principle of internal customers. The third problem is connected to project management when problems from the stage of pre-serial production remain unsolved and continues to serial stage of production causing enormous financial loss. The main factors can be insufficient machinery preparation in terms of performance, technological parameters optimization, insufficient amount of quality tools, and finally capable manufacturing parts. The fourth problem deals with the department of production preparation. Continuity of production preparation on produced quality in some companies literally does not exist. The members of this department are mainly oriented on quantity of production rather than quality of production. Within this department there are too important approaches going hand in hand and must be considered which are the quality and the dependability. Poor understanding of quality and dependability philosophy leads within machinery investment policy (specification, design, and acquisition) into situations when the machines are incapable to reach parameters required and expected by customers, particularly the capability indices, functional, and capacity parameters. Moreover, the quality itself is not enough and the reliability, especially its partial characteristics such as failure-free operation, maintainability, repair ability, diagnostic ability, and preparedness of maintenance must be taken into account. The fifth and final problem is connected to maintenance organization. Across the wide range of companies the quality maintenance plans are unavailable and the principles of predictive and proactive maintenance are completely missing. Maintenance interventions are not planned based on the “Theory of Renovation” but rather solved consequently after the failure occurs. This sort of approach can cause even an interruption of production in follow up process, particularly in a customer factory with enormous financial loss. The important issue relates to tools management. The present practice is mainly based upon intuition instead of decision relating to optimum lifespan determination from the “Theory of Renovation” methodology. The same issue includes the optimization of deposit of key spare parts in terms of types and the quantity. One of the frequently common situations is the one when a need of particular spare part or tool replacement is necessary and the component is not available at the moment. Then the production uses defective tool being aware of risk in terms of non-conform products manufacturing. Within maintenance organization the model procedures and instructions are missing which is steering into protraction of repairs, increasing the risk of on time root cause uncovering, and heterogeneous approach of mechanics to machinery interventions. In connection to used system of haphazard maintenance no devices of technical diagnostic are implemented and used. With realization of maintenance intervention as the curative actions of failures occurrence, no methods as PDCA (Plan Do Check Act), and the rules for testing parts treatment are used or followed that can wind up with intermix of conform and non-conform parts. Ultimately, the insufficient or no records are kept and the rest does not provide necessary information as failure root cause and the process of its elimination. Afterwards, it makes impossible to set up the feedback in order to increase the effectiveness of maintenance system. When quality system is incorrectly established in an organization, all above mentioned problems can be detected. Their common factor is low interest and involvement of top management in terms of support and development of the system of quality. Such a low management involvement stems from a lack of knowledge or the underestimation of the system of quality and its ability for its practical utilization in terms of cost optimization. It is a common practice that company`s processes are not precisely enough defined and the matrix of responsibility and substitutability not implemented. One of the most important issues is the process interface where the interaction between two processes (departments) occurs. These process interfaces are not accurately specified and causing situations when one department switches its responsibility to another department even though it is its own responsibility. This sort of "ping-pong" diminishes the company goodwill for the necessary actions are not solved properly and not on time. The same approach covers also the urgent and the critical events like countermeasure actions which should be solved within hours. Company standards, norm, and procedures often do not correspond with reality and activities are performed unsystematically and in some cases in contradiction with requirements. The final question is the relationship between supplying organization and the customer(s). The most observed relation is the mutual distrust between customer organization and its supplier which is caused by mutual idle cooperation when regular meetings with customer are not held and where the actual problems might be discussed and solved. Mutual trust building is a long term effort which goes hand in hand with a moral profile of company.

3. Contemporary education in the field of quality assurance and reliability engineering

Topics focused on quality assurance and dependability of machines are lectured within faculty curriculum in three independent subjects. The principles of management of quality are a content of subject "Quality Assurance". The students are introduced to a conception, principles, significance and organization of quality assurance in industrial sphere. The subject is further oriented on quality within pre-production, production, and post-production stages, cost monitoring methods, and methods of continuous improvement. Inseparable parts of the subject are basic tools and methods of quality management, audits, certification and EMS (Environmental Management System) [3]. Present weakness which the attention should be focused on is claim management, customer related management, suppliers management, knowledge of methods as PPAP (Production Part Approval Process), PSW (Part Submission Warrant), and APQP (Advanced Product Quality Planning). Moreover, the necessity is a practical usage of G8D (Global 8 Disciplines of Problem Solving) methodology, QFD (Quality Function Deployment), TRIZ (Theory of Inventive Problem Solving), and 6 Sigma as well as the audit techniques, and quality evaluation techniques. Fundamentals of machinery operation and dependability are lectured in two subjects which are the "Machinery Operation and Maintenance" and "Measurement and Technical Diagnostics". In the range of these two subjects the students study present knowledge and new findings from field of wear and material degradation during exploitation of machine parts and systems having influence on changes of operational parameters and characteristics of machinery. Besides, the subject content is oriented on the theory of maintenance and repairs, maintenance systems and processes, maintenance organization, and the tools and devices for maintenance assurance [3]. The subject "Measurement and Technical Diagnostics" is oriented on attainment of skills in area of measurement techniques, methods, sensors, signal processing, and further on ability to use diagnostics methods in order to identify place, range, and failure cause origin. Afterwards, based on failure detection and diagnosis determination to create a prognosis of further technical development and prescribe interventions of maintenance and strive for finding an optimum solution for return of the machinery and technical equipment into serviceable state. Additional target is the understanding the significance of technical diagnostics for an economical and safety machinery operation when the students obtain a view of principles of diagnostic signals reading, with methods of signal processing, and understanding when form a diagnose. Students are informed about contemporary methods and trends in technical diagnostics primarily with measurement of operational parameters using tribology, vibrodiagnostics, and termodiagnostics as the most used methods in industry. The opportunities for an improvement here are an integration of optimization principles from "Theory of Renovation" and knowledge extend in machinery and mechanical parts design in terms of function and utilization. Prerequisite of practical preparation for the students is creation of technical diagnostics laboratory.

4. The industry needs implementation into the educational system

Over a span of five years of observations within automotive supply chain audits realization and after an analysis of mechanical engineering oriented curriculums, and supported with previously defined gaps and weaknesses notable modifications in lectured subjects can be executed. In order to overcome the obstacles and satisfy the products end users it is necessary to connect the needs of automotive industry with university program offers as it was mentioned previously. The proposed areas of implementation are determined in the following table.

Table 1. The areas for an improvement

1	Clarification of principles of the Quality & dependability management and their significance in industrial practice and everyday life.
2	Emphasize the process orientation and processes interfaces, process control, and systemic approach.

3	Elucidate the significance and the techniques of problem prevention instead of subsequent elimination.
4	Acquire the skills of problem solving methods within root cause analysis.
5	Learning of the contemporary methods for supplier's selection, approval, and administration with utilization of international methods.
6	To learn the principles of Project Management in connection to quality assurance and dependability of machines.
7	To obtain the practical skills from organization and management of maintenance.
8	Getting knowledge of audit techniques in quality assurance and maintenance sphere.
9	Understanding of G8D, TRIZ, and Six Sigma methods.
10	Integration of "Theory of Renovation" into the present curriculum.
11	Integration of autonomous subject oriented on design of manufacturing machines and equipment.
12	Build up the laboratory of "Technical Diagnostics".

For thriving implementation above mentioned areas of development it is necessary elaborate a set of case studies based on real problems from the industry which by the form of team work or workshops will be solved by the students. Especially at JEP University it is necessary to built up the "Technical diagnostics" laboratory, prepare measurement procedures, and create model defects, that students will deal with. Theoretical passages will be integrated in lectures syllabuses and via mutual-subject connections a synthesis of knowledge will be realized. Additional eventuality is extension of curriculum about two new subjects the "Manufacturing machinery design" and "Quality and Dependability of Machines.

5. Conclusion

Principles of quality and dependability are inherently incorporated in each particular company process and activity, and surely that is why their understanding is competitive advantage on market place. The university graduates in order to be able succeed in an managerial position in terms of being able manage, organize, and effectively make decisions, certainly must understand and use fundamental principles of quality and dependability integrated into the complex machinery and device care. The above mentioned lectured subjects help the students being prepared for an effective performance of their job positions. There is also significant contribution to society in a form of quality oriented people which is not merely machinery oriented quality but the quality of life itself too. Furthermore, the proposed improvement can guarantee either a competitive advantage before contemporary practice or at least help to disengage from present problems and improve and streamline their processes as well. The objective of the article was to reveal and show the present reserves and detect areas and points for an improvement and through the education process suggest the transfer to the industrial practice.

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SPECIAL FRACTAL SHAPE AND ITS FEATURES

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Abstract
In this paper we introduced the concept of fractals and fractal dimensions as well as their methods of computation in classical examples of fractals. Emphasis will be placed on a special form of fractal in space and the method using the resulting analog formats will be explained. One will stress the importance of area area, the volume of fractals and the mathematical expressions obtained using real data. When designing fractal geometry, it is necessary to know the basis and the motive. If each base line replaces shape motives and that process continues to infinity, the result is a fractal. One can say that fractals are a set of points that have 3 important characteristics: self similarity, fractal dimension and the formation by iteration.
In this paper, comparison will be made between a known fractal in the plane, which is the Koch curve, and the fractal in space, which is our "Super pyramid". Fractal geometry finds its origin in new branches of science, such as mathematical modeling, open views on the world and creating the deterministic chaos theory.

Keywords:
Tetrahedron, tetrahedron net, fractal dimension, self similarity, fractal geometry.

1. Introduction

At the beginning of the 70s of the last century Mandelbrot described the mathematics that we have today, helping with the analysis of irregularities in the world i.e. new objects called fractals. During the last few decades, understanding of dimensionality has drastically changed the concept of fractal dimension. Many things and objects in the environment consist of simple geometric shapes (rectangles, triangles) that form complex geometric figures. The patterns of trees, ferns, mountains, clouds, bacteria, etc. can be listed as examples of fractal shapes.
A fractal is an object or quantity that displays self-similarity, in a somewhat technical sense, on all scales. The object need not exactly to exhibit the same structure at all scales, but the same "type" of structure must appear on all scales. The fractal dimension is strictly greater than topological [1].

2. Examples of fractal set and shape

When designing fractal geometry, it is necessary to know the basis and the motive. The base is any shape that is composed of line segments, while the motive is in some other form, which also consists of lines. If each line of the base can be replaced by shape motives and that process continues to infinity, the result is a fractal.
For easier understanding, we will list an example. Take a straight line given in length. Divide the length into three sections, the middle part is protruded and divided into two new lines of equal length that come together and form the top of an angle of 60 degrees. Repeat this procedure once again, and again, and so on, indefinitely. Actually it is a process of iteration [4].
If this procedure is repeated indefinitely than this represents the process of iteration.

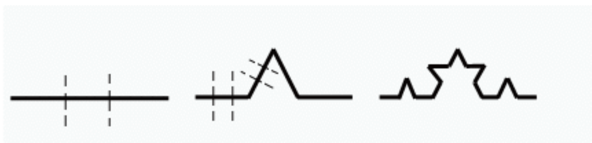

Figure 1. Basis and motive of Koch curve

3. Fractals in the plane

One of the first curves described is the Koch curve. It was presented and analysed by the Swedish mathematician Niels Fabian Helge in 1904. It is often used as a representative example in order to explain the notion of fractals, sets of fractals, fractal dimensions as well as the methods of construction and iteration. Koch's curve is created when a line of a certain length is divided into three equal parts. The middle part is then replaced by two new lines of equal length, that are protruded. These two new protruded lines come together forming thus an angle of 60 degrees. The same procedure is then being repeated with each new set of lines. Koch's curve is based on length iteration, Koch's snowflake on triangle iteration.
If we repeat the process we obtain a series of geometrical objects $K_1, K_{2,} \dots, K_n, \dots$.

Figure 2 and 3 show and describe the process of creating the above mentioned set of fractals.

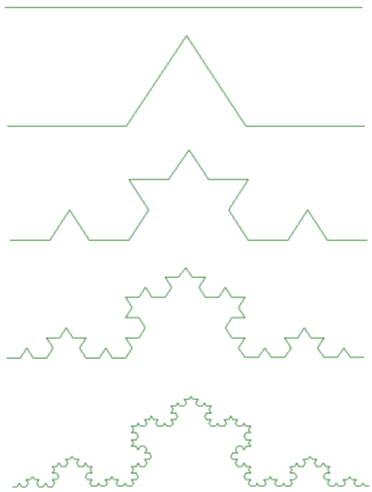

Figure 2. The construction of Koch's curve

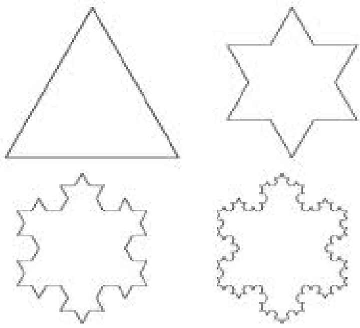

Figure 3. The construction of Koch's snowflake

The interesting thing about Koch's snowflake is its perimeter that gets bigger after each iteration thus growing into infinity.

The perimeter of the intial geometrical object is:

$$O_1 = 3 \cdot 1 \tag{1}$$

The other geometrical object has $3 \cdot 4$ sides of a length of $\frac{1}{3}$. Thus,

$$O_2 = 3 \cdot 4 \cdot \frac{1}{3} \tag{2}$$

The third object has $3 \cdot 4 \cdot 4$ sides of a length of $\frac{1}{3^2}$. Thus,

$$O_3 = 3 \cdot 4^2 \cdot \frac{1}{3^2} \tag{3}$$

Therefore it is generally true:

$$O_n = 3 \cdot 4^{n-1} \cdot \frac{1}{3^{n-1}} = 3 \cdot \left(\frac{4}{3}\right)^{n-1} \tag{4}$$

A sequence O_n is divergent because it is a geometrical sequence with a quotient.

$$\varepsilon = \frac{4}{3} > 1 \tag{5}$$

This means that the perimeter of geometrical objects $K_1, K_{2,} \dots, K_n$ grows indefinitely when $n \to \infty$. Thus, Koch's curve is a curve of an indefinite perimeter.
As long as the perimeter of the curve is limited by a circular that describes the initial triangle, the areas can be calculated via the geometric series taking into account the initial area of the triangle

The area of an initial geometrical object is:

$$P_1 = \frac{\sqrt{3}}{4} \tag{6}$$

The area of another object is obtained by increasing the initial area of P_1 by the area of three equilateral triangles with side $a = \frac{1}{3}$ and is :

$$P_2 = P_1 + 3 \cdot \frac{1}{9} \cdot \frac{\sqrt{3}}{4} \tag{7}$$

The area of a third object is:

$$P_3 = P_2 + 3 \cdot 4 \cdot \frac{1}{9^2} \cdot \frac{\sqrt{3}}{4} \tag{8}$$

Generally:

$$P_n = P_{n-1} + 3 \cdot 4^{n-2} \cdot \frac{1}{9^{n-1}} \cdot \frac{\sqrt{3}}{4} \tag{9}$$

The area of the n-th geometrical object is:

$$P_n = \frac{\sqrt{3}}{4} + \frac{3\sqrt{3}}{20}\left[1 - \left(\frac{4}{9}\right)^{n-1}\right] \tag{10}$$

A sequence (Pn) is convergent and has a limit:

$$P = \lim_{n\to\infty} P_n = \frac{\sqrt{3}}{4} + \frac{3\sqrt{3}}{20} = \frac{2\sqrt{3}}{5} \tag{11}$$

The area of geometrical objects $K_1, K_{2,} \dots, K_n$ converges towards a number when $n \to \infty$.
According to that, the snowflake is a closed curve that closes a definite area [5].

The fractal dimension does not always have to be a whole number, when regarding its defintion the characteristic of self-similarity is used. If an object can be divided into N of its reduced copies with a length f, then the following applies:

$$N = \left(\frac{1}{f}\right)^D \quad (12)$$

Where D is the dimension of the fractal object, that reads as follows from the previous definition:

$$D = \frac{\log N}{\log \frac{1}{f}} \quad (13)$$

The topologic dimension is 1, the fractal dimension between one and two. The calculation is explained in the next step [3].
In the next iterative step, in the process of creating Koch's curve, there are 4 lengths with a length of $\frac{1}{3}$, and when putting them into the formula (13) we get:

$$D = \frac{\log 4}{\log 3} = 1.2619 \quad (14)$$

Which confirms that it is not always a rational number, but it is also not a whole number. It is also said that fractal dimensions are also broken dimensions [2].

4. Fractals in space
Platonic solid or regular polyhedrons are polyhedrons that have sides consisting of regular polygons and the angles between the sides are of equal sizes. There exist only five such bodies and these are: tetrahedron, heksahedron, octahedron, dodecahedron and icosahedron. Euler's theorem applies to them which states that: the total number of vertices and the sides for each polyhedron is 2 times bigger than the number of its edges, i.e.

$$v - b + s = 2 \quad (15)$$

Where v is the number of vertices, b is the number of edges and s is the number of sides.

For this paper the tetrahedron is very interesting. The tetrehedron is a regular polyhedron that has 4 vertices, 6 edges and 4 sides (equilateral triangles). A pyramid with three sides having all edges of equal length is called a tetrahedron. The net of a tetrahedron has 4 equilateral triangles, one triangle representing the base and the other three triangles forming the sides of the tetrahedron.

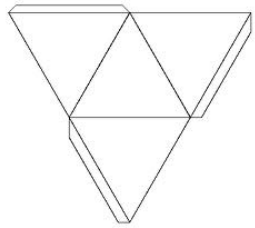

Figure 4. The net of a tetrahedron

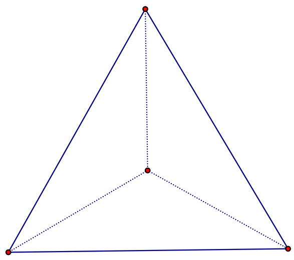

Figure 5. Tetrahedron

Connecting plane and space, it is possible to come to an analogy.
An equilateral triangle in a plane has its analogue in space which is the tetrahedron.
In a plane perimeter and area are calculated, in space area and volume.

If the edge of a tetrahedron has length a, the formula for the area is:

$$A = 4 \cdot \frac{a^2\sqrt{3}}{4} = a^2\sqrt{3} \quad (16)$$

The formula for the volume of a pyramid is :

$$V = \frac{B \cdot h}{3} \quad (17)$$

Seen the fact that the studied tetrahedron is a threeside pyramid B is the area of the base i.e. the area of an equilatera triangle and h is the height of the tetrahedron.
After substituting and editing get a final expression for the volume of the tetrahedron:

$$V = \frac{\frac{a^2\sqrt{3}}{4} \cdot \frac{a\sqrt{6}}{3}}{3} = \frac{a^3\sqrt{2}}{12} \quad (18)$$

Fractal set in the plane of the triangle we started, we have the motive and the base and construct a Koch's snowflake after a few iterations. Similarly, we have a tetrahedron in space, and we have the base and motive net of tetrahedron and after several iterations and structures in program The Geometer's Sketchpad get a fractal set which we call "super-pyramids."

Iteration moves with three its faces (sides) of the basic tetrahedron we construct a new net of tetrahedron, then the new net and makes a new smaller tetrahedron whose edge is half of the original, which also has three of its its faces, and his base is located at the base tetrahedron's faces. Process is repeated several times and get more complex and interesting fractal set in space.

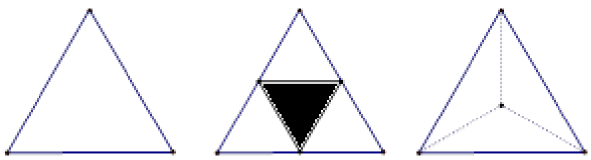

Figure 6. The first iteration

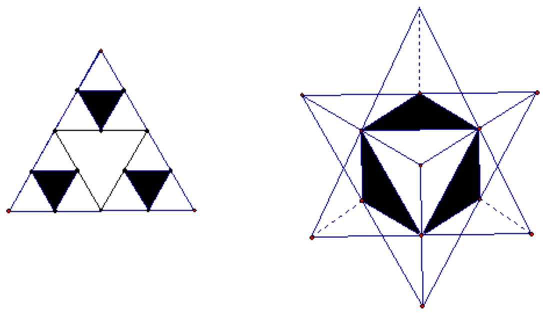

Figure 7. The second iteration (Stella Octangula)

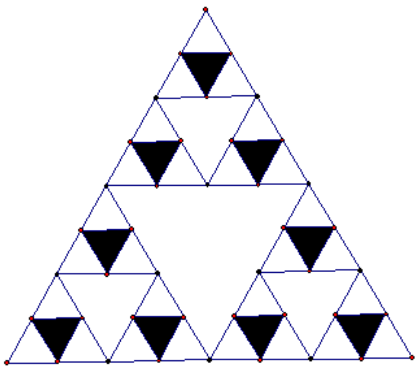

Figure 8. The third iteration

The volume of the tetrahedral body can be expressed by the geometric series with initial terms $\frac{\sqrt{2}}{12}a^3$ and ratio $\frac{3}{8}$:

$$\begin{aligned} V &= \frac{\sqrt{2}}{12}a^3 + 3\cdot\frac{\sqrt{2}}{12}\left(\frac{a}{2}\right)^3 + 3^2\cdot\frac{\sqrt{2}}{12}\left(\frac{a}{2^2}\right)^3 + \cdots \\ &= \sum_{n=0}^{\infty} 3^n\cdot\frac{\sqrt{2}}{12}\left(\frac{a}{2^n}\right)^3 = \frac{\sqrt{2}}{12}a^3\sum_{n=0}^{\infty}\left(\frac{3}{8}\right)^n \\ &= \frac{\sqrt{2}}{12}a^3\cdot\frac{8}{5} = \frac{2\sqrt{2}}{15}a^3 \end{aligned} \tag{19}$$

The area of the tetrahedral body can be expressed by sum of the separated member $\frac{\sqrt{3}}{4}a^2$, and the geometric series with initial terms $\frac{9\sqrt{3}}{16}a^2$ and ratio $\frac{3}{4}$:

$$\begin{aligned} A &= \frac{\sqrt{3}}{4}a^2 + \frac{9\sqrt{3}}{16}a^2 + 3\cdot\frac{9\sqrt{3}}{16}\left(\frac{a}{2}\right)^2 + \\ &\quad + 3^2\cdot\frac{9\sqrt{3}}{16}\left(\frac{a}{2^2}\right)^2 + \cdots \\ &= \frac{\sqrt{3}}{4}a^2 + \sum_{n=0}^{\infty} 3^n\cdot\frac{9\sqrt{3}}{16}\left(\frac{a}{2^n}\right)^2 = \\ &= \frac{\sqrt{3}}{4}a^2 + \frac{9\sqrt{3}}{16}a^2\sum_{n=0}^{\infty}\left(\frac{3}{4}\right)^n \\ &= \frac{\sqrt{3}}{4}a^2 + \frac{9\sqrt{3}}{16}a^2\cdot 3 = \frac{31\sqrt{3}}{16}a^2 \end{aligned} \tag{20}$$

5. Conclusion

The results obtained by iteration and geometric construction shows that the basis and motive given shape divided into infinity. Fractal dimension is a value that determines the perimeter to which fractal fills the space in which it is located. Fractal dimension is also called broken dimension because it is not necessarily an integer. In contrast to the topological dimension which is always a natural number. On this basis we can conclude that fractal dimension is almost always a rational number.

Koch's snowflake in a simple way to demonstrate one of the known properties of fractals. Infinitely long boundary encloses the final area. "Super pyramid" followed by analogy. The body that has a finite volume and finite area.

The purpose of this is to present heuristics or ars inveniendi, which is important in mathematics, and not only in mathematics.

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BARYCENTERS AND CONVEX FUNCTIONS

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Abstract
We deal with the convex functions on the bounded closed convex sets with common barycenter. More precisely, the integral arithmetic means of convex function f are compared on these two sets A and B so that $A \subset B$. The paper shows that the double inequality

$$\frac{1}{\mu(A)}\int_A f(x)\,d\mu(x) \le \frac{1}{\mu(B)}\int_B f(x)\,d\mu(x) \le \le \frac{1}{\mu(B\setminus A)}\int_{B\setminus A} f(x)\,d\mu(x) \tag{1}$$

holds for convex functions of one variable, but it does not generally hold for convex functions of several variables.

Keywords
Jensen's inequality, double inequality, barycenter, convex set, convex function

1. Introduction

1905th a Danish mathematician Jensen has found an important inequality related to the convex function. During the last century it has been shown that it is one of the most important mathematical inequalities. The primary form of the Jensens inequality is:

$$f\left(\sum_{i=1}^{n} p_i x_i\right) \le \sum_{i=1}^{n} p_i\, f(x_i) \tag{2}$$

with points x_i from the interval $I \subseteq \mathbb{R}$, coefficients p_i from the interval [0,1] such that $\sum_{i=1}^{n} p_i = 1$ and convex function $f: I \to \mathbb{R}$. Jensen's inequality also has an integral form (for example see [4, page 44]).

1963rd in [1] probabilistic variant of the inequality (3) was obtained

$$\frac{1}{\mu(A)}\int_A f(x)\,d\mu(x) \le \frac{1}{\mu(B)}\int_B f(x)\,d\mu(x) \tag{3}$$

in which the barycenters can be observed.

2. The integral variants of Jensen's inequality

The notion of the arithmetic mean can be extended on sets and functions with help of measure and integral theory. This concept is barycenter for sets and integral arithmetic mean for functions. Let μ be a measure on $\mathbb{R}^n$. Consequently, the barycenter of μ-measurable set $S \subset \mathbb{R}^n$ (barycenter with respect to measure μ) is the n-tuple

$$s_\mu = \frac{1}{\mu(S)}\int_S s\,d\mu(s) \tag{4}$$

with coordinates

$$\left(s_\mu\right)_i = \frac{1}{\mu(S)}\int_S s_i\,d\mu(s) \quad \text{for } i = 1, \dots, n \tag{5}$$

The point s_μ is called μ-barycenter. The integral arithmetic mean of μ-integrable function g on set S (integral arithmetic mean with respect to measure μ) is the real number

$$g_{s_\mu} = \frac{1}{\mu(S)}\int_S g(s)\,d\mu(s) \tag{6}$$

The number g_{s_μ} is called μ-integral arithmetic mean. A basic connection between the barycenter and the integral arithmetic mean is written in the integral form of Jensen's inequality. Integral forms of the famous Jensen's inequality can be found in the books in [4] and [6].

We recall known general facts about barycentres of bounded sets from $\mathbb{R}^n$.

Lemma 2.1.
Let μ be a measure on $\mathbb{R}^n$. Let A and B be bounded closed sets from $\mathbb{R}^n$ such that $A \subset B$ and $0 < \mu(A) < \mu(B)$,

$$\frac{1}{\mu(A)}\int_A x\,d\mu(x) = \frac{1}{\mu(B)}\int_B x\,d\mu(x) \tag{7}$$

Than which completes the proof.

$$\frac{1}{\mu(A)}\int_A x\,d\mu(x) = \frac{1}{\mu(B\setminus A)}\int_{B\setminus A} x\,d\mu(x) \tag{8}$$

Proof.
Using the properties of integral and the assumption, we get

$$\begin{aligned}
&\frac{1}{\mu(B\setminus A)}\int_{B\setminus A} x\,d\mu(x) = \\
&= \frac{1}{\mu(B\setminus A)}\left(\int_B x\,d\mu(x) - \int_A x\,d\mu(x)\right) \\
&= \frac{1}{\mu(B\setminus A)}\left(\frac{\mu(B)}{\mu(A)}\int_A x\,d\mu(x)\right. \\
&\left.- \int_A x\,d\mu(x)\right) = \frac{\mu(B)-\mu(A)}{\mu(B\setminus A)}\int_A x\,d\mu(x) \\
&= \frac{1}{\mu(A)}\int_A x\,d\mu(x)
\end{aligned} \tag{9}$$

which ends the proof. ■

Geometrical and mechanical meaning of Lemma 1.1: If λ is μ-barycenter of the sets A and B with $A \subset B$, then λ is μ-barycenter of the set $B \setminus A$ also.

Lemma 2.2.
Let μ be a measure on $\mathbb{R}^n$. Let A and B be bounded closed sets from $\mathbb{R}^n$ such that $A \subset B$ and $0 < \mu(A) < \mu(B)$.
If one of the equalities

$$\begin{aligned}
\frac{1}{\mu(A)}\int_A x\,d\mu(x) &= \frac{1}{\mu(B)}\int_B x\,d\mu(x) = \\
&= \frac{1}{\mu(B\setminus A)}\int_{B\setminus A} x\,d\mu(x)
\end{aligned} \tag{10}$$

is valid, then the double equality

$$\begin{aligned}
\frac{1}{\mu(A)}\int_A h(x)\,d\mu(x) &= \frac{1}{\mu(B)}\int_B h(x)\,d\mu(x) = \\
&= \frac{1}{\mu(B\setminus A)}\int_{B\setminus A} h(x)\,d\mu(x)
\end{aligned} \tag{11}$$

holds for every affine function $h(x) = h(x_{1,} \dots, x_n) = \sum_{i=1}^n k_i x_i + l$

Proof.
Since,

$$\frac{1}{\mu(A)}\int_A x_i\,d\mu(x) = \lambda_i \tag{12}$$

with it follows that.

$$\begin{aligned}
&\frac{1}{\mu(A)}\int_A h(x)\,d\mu(x) = \\
&= \sum_{i=1}^n \frac{k_i}{\mu(A)}\int_A x_i\,d\mu(x) + \frac{l}{\mu(A)}\int_A d\mu(x) \\
&= \sum_{i=1}^n k_i\lambda_i + l
\end{aligned} \tag{13}$$

The proof is done. ■

In order to get a practical description of Lemma 1.2 let us define a measure ν on $h(B)$ by the rule,

$$\nu(h(A)) = |k|\,\mu(A) \tag{14}$$

for all μ-measurable subsets A of B, excluding the case $k = 0$. Geometrical and mechanical meaning of Lemma 2.2 is the following:
If λ is μ-barycenter of the sets $A, B, B \setminus A$ with $A \subset B$; then $h(\lambda) = k\lambda + l$ is ν-barycenter of the sets $h(A), h(B), h(B \setminus A)$.

Theorem 2.3.
Let μ be finite measure on the non-degenerate interval I. Let A and B be bounded closed intervals from I such that $A \subset B$ and $0 < \mu(A) < \mu(B)$.
If one of the equalities

$$\begin{aligned}
\frac{1}{\mu(A)}\int_A x\,d\mu(x) &= \frac{1}{\mu(B)}\int_B x\,d\mu(x) = \\
&= \frac{1}{\mu(B\setminus A)}\int_{B\setminus A} x\,d\mu(x)
\end{aligned} \tag{15}$$

is valid, then the double equality

$$\begin{aligned}
\frac{1}{\mu(A)}\int_A f(x)\,d\mu(x) &\le \frac{1}{\mu(B)}\int_B f(x)\,d\mu(x) \le \\
&\le \frac{1}{\mu(B\setminus A)}\int_{B\setminus A} f(x)\,d\mu(x)
\end{aligned} \tag{16}$$

holds for every convex function $f : I \to \mathbb{R}$.

Proof.
If $A = [a_1, a_2]$, let $y = h_A^{cho}(x)$ be a chord line through points $T_1(a_1, f(a_1))$ and $T_2(a_2, f(a_2))$.

Applying the convexity of f and Lemma 2.2, first we can conclude the inequality and we prove with we can derive.

$$\frac{1}{\mu(A)}\int_A f(x)\,d\mu(x) \le \frac{1}{\mu(A)}\int_A h_A^{cho}(x)\,d\mu(x) = \frac{1}{\mu(B\setminus A)}\int_{B\setminus A} h_A^{cho}(x)\,d\mu(x) \le \le \frac{1}{\mu(B\setminus A)}\int_{B\setminus A} f(x)\,d\mu(x) \tag{17}$$

Using this result we prove the left-hand side of the inequality in (16):

$$\frac{1}{\mu(A)}\int_A f(x)\,d\mu(x) = = \frac{\mu(B)}{\mu(B)\mu(A)}\int_A f(x)\,d\mu(x) = = \frac{\mu(A)+\mu(B\setminus A)}{\mu(B)\mu(A)}\int_A f(x)\,d\mu(x) =$$

$$= \frac{1}{\mu(B)}\left(\int_A f(x)\,d\mu(x) + \frac{\mu(B\setminus A)}{\mu(A)}\int_A f(x)\,d\mu(x)\right) \tag{18}$$

$$\le \frac{1}{\mu(B)}\left(\int_A f(x)\,d\mu(x) + \int_{B\setminus A} f(x)\,d\mu(x)\right) = \frac{1}{\mu(B)}\int_B f(x)\,d\mu(x)$$

Using the first result we derive the right-hand side of the inequality in (16):

$$\frac{1}{\mu(B)}\int_B f(x)\,d\mu(x) = = \frac{1}{\mu(B)}\left(\int_A f(x)\,d\mu(x) + \int_{B\setminus A} f(x)\,d\mu(x)\right) \le \frac{1}{\mu(B)}\left(\frac{\mu(A)}{\mu(B\setminus A)}\int_{B\setminus A} f(x)\,d\mu(x) + \int_{B\setminus A} f(x)\,d\mu(x)\right) = \frac{1}{\mu(B\setminus A)}\int_{B\setminus A} f(x)\,d\mu(x) \tag{19}$$

So, we have the proof. ■

3. The counterexamples for convex functions of two and three variables on polytopes with common barycenter

It is important to determine whether Theorem 2.3 is valid in the case when convex sets A and B belong to Euclidean space $\mathbb{R}^n$. Unfortunately, already for $n = 2$ in Theorem 2.3 generally does not hold. In the next two examples the reverse inequalities hold for bounded closed convex sets, Lebesgue measure μ $(d\mu(x) = dx)$, that is, the Lebesgue integral reduced to the Riemann integral and convex functions of two or three variables.
The two following examples are shown in the paper [5]. The convex hull of a set S will be denoted by co$S$.

Example 3.1. For polytopes A (four vertices) and B (six vertices) with common barycenter in origin,

$$A = co\left\{\left(\pm 1, \pm\frac{1}{2}\right)\right\} \quad and \quad B = co\left\{\left(\pm 1, \pm\frac{1}{2}\right), \left(0, \pm\frac{3}{2}\right)\right\}$$

and convex function

$$f(x) = f(x_1, x_2) = \begin{cases} x_1 & for \quad x_1 \ge 0 \\ 0 & for \quad x_1 \le 0 \end{cases}$$

the following holds true:

$$\frac{1}{\mu(A)}\int_A f(x)\,d\mu(x) > \frac{1}{\mu(B)}\int_B f(x)\,d\mu(x) > > \frac{1}{\mu(B\setminus A)}\int_{B\setminus A} f(x)\,d\mu(x) \tag{20}$$

Proof.
Obviously, the measures of the sets A, B and $B\setminus A$ are $\mu(A) = 2$, $\mu(B) = 4$ and $\mu(B\setminus A) = 2$.

Calculating the double integrals, we get:

$$\frac{1}{\mu(A)}\int_A f(x)\,dx = \frac{1}{2}\int_0^1 x_1\,dx_1 \int_{-\frac{1}{2}}^{\frac{1}{2}} dx_2 = \frac{1}{4} \qquad \frac{1}{\mu(B)}\int_B f(x)\,dx = \frac{5}{24} \qquad \frac{1}{\mu(B\setminus A)}\int_{B\setminus A} f(x)\,dx = \frac{1}{6} \tag{21}$$

The series of inequalities in (20) is satisfied with the above values. ■

Example 3.2. For polytopes A (eight vertices) and B (ten vertices) with common barycenter in origin,

$$A = co\left\{\left(\pm 1, \pm\frac{1}{2}, \pm 1\right)\right\} \quad and$$
$$B = co\left\{\left(\pm 1, \pm\frac{1}{2}, \pm 1\right), \left(0, \pm\frac{3}{2}, 0\right)\right\}$$

and convex function

$$f(x) = f(x_1, x_2, x_3) = \begin{cases} x_1 & for \quad x_1 \geq 0 \\ 0 & for \quad x_1 \leq 0 \end{cases}$$

the following holds true:

$$\frac{1}{\mu(A)}\int_A f(x)\,d\mu(x) > \frac{1}{\mu(B)}\int_B f(x)\,d\mu(x) > \\ > \frac{1}{\mu(B\setminus A)}\int_{B\setminus A} f(x)\,d\mu(x) \quad (22)$$

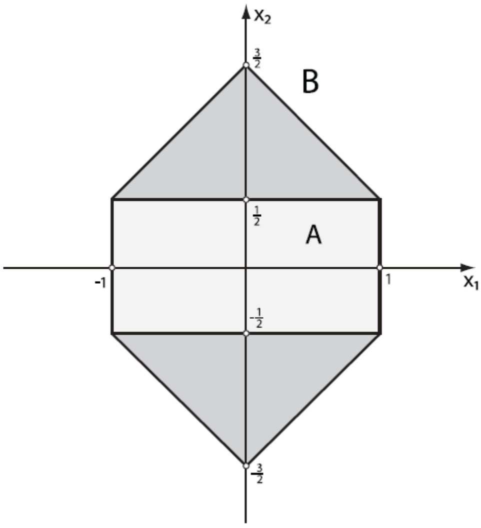

Figure 1. Polytopes with four and six vertices

Proof.
The measures of the sets A, B and $B \setminus A$ have the values $\mu(A) = 4$, $\mu(B) = \frac{20}{3}$ and $\mu(B\setminus A) = \frac{8}{3}$. Calculating the triple integrals, we have:

$$\frac{1}{\mu(A)}\int_A f(x)\,dx = \\ \frac{1}{4}\int_0^1 x_1 dx_1 \int_{-\frac{1}{2}}^{\frac{1}{2}} dx_2 \int_{-1}^{1} dx_3 = \frac{1}{4} \\ \frac{1}{\mu(B)}\int_B f(x)\,dx = \frac{9}{40} \\ \frac{1}{\mu(B\setminus A)}\int_{B\setminus A} f(x)\,dx = \frac{3}{16} \quad (23)$$

Thus, the series of inequalities in (22) is satisfied with calculated values. ■

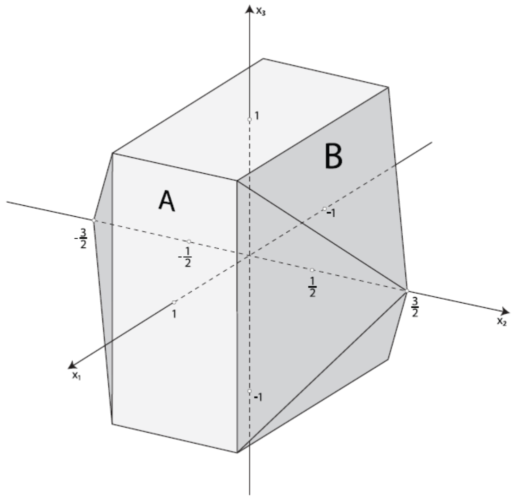

Figure 2. Polytopes with eight and ten vertices

4. Conclusion
We can conclude that the inequality

$$\frac{1}{\mu(A)}\int_A f(x)\,d\mu(x) \leq \frac{1}{\mu(B)}\int_B f(x)\,d\mu(x) \leq \\ \leq \frac{1}{\mu(B\setminus A)}\int_{B\setminus A} f(x)\,d\mu(x) \quad (24)$$

is valid only for convex functions of one variable. As we have shown in examples, the neither part of these double inequality is not true for convex functions of several variables.

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ANALYSIS OF DIFFERENCES IN ORIENTATION BETWEEN YOUNG FEMALE GYMNASTS

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Abstract
The primary objective of this study was to compare and explain the results in the orientation of young gymnasts, team members (competitors, more successful) and those who train recreationally (less successful). In accordance with the objectives, the sample of 69 female gymnasts aged 7-12 years was used and TEOSQ questionnaire was applied. Obtained results primarily indicate high values in both observed orientation dimensions in both groups of young gymnasts. We also observed the existence of significant differences in the dimensions of the observed orientation within the group of more successful gymnasts ($p<0.001$) and less successful ($p<0.001$) as well as on the entire sample ($p<0.001$). Furthermore, significant differences were not found among groups in the task orientation ($p=0.75$), while young competitors have significantly higher results in ego orientation ($p<0.05$). These results clearly indicate, due to the further quality education young gymnasts, the need for scientific research of the relationships between task/ego orientations with other specific gymnastic motor skills.

Keywords: task orientation, ego orientation, TEOSQ, gymnastics, differences

1.Introduction

Information about the dominant approach to motor learning represents essential information about every programmed kinesiological treatment within education, elite sport or recreation [8]. There are two basic approaches to physical activity: extrinsic or ego orientation (EO) and intrinsic or task orientation (IO) [5]. The same authors state that a person with a dominant EO is primarily focused on outcomes and generally guided by the desire for superiority and competition with others. Such people, demonstrating that they are better than their competition colleagues assume their successfulness. On the other hand, person with a dominant IO have aims to learn and improve their skills and their personal goal is to refine and improve performance. It is important to point out that these two dimensions are not mutually exclusive, and that same person can have high scores or low scores in both these dimensions [1]. Furthermore, same authors specify the existence of four possible orientation profiles: high IO/high EO, low IO/low EO, high EO/low IO and low IO/high EO. Although there are four possible orientation profiles possible, studies show how there two are dominant: high IO/low EO and low IO/high EO [12].

Gymnastics is a specific polystructural and acyclic sport activity in which under the term “athletes”, even the term “top athletes”, children even younger than 10 years are considered. Gymnastics rules are requiring that each element is performed technically perfect and aesthetically acceptable, as defined by strict rules. For children to reach a specified level of motor knowledge, it is crucial that they are highly task oriented [8], [11]. It is therefore important to focus children on themselves, on their mistakes and shortcomings, regardless of the other. Accordingly, coaches and other staff in gymnastic clubs should create a motivational climate in which task orientation or intrinsic motivation would be predominant. Our behavior is the result of complex interactions of a large number of psycho-social dimensions, especially motives which are associated by reciprocal, non-linear relationships [3], [9].

Different motives can be manifest in a similar way and also similar motives can be manifested in various ways [12]. Accordingly, the orientation of athletes will certainly depend on their experience, various social factors (ambitious parents) and the motivational climate. Scientific research suggests that in any collective sports, especially in younger age categories, it is desirable to overcome the ego orientation [2]. In accordance with the above mentioned, task orientation is certainly a prerequisite for a positive motivational climate within the sport club.

In school age, sport is a main segment of socialization, and attitude toward the sport has an important role in developing of self-confidence. Different attitudes towards activities are usually determined by cognitive and motivational factors, and it is appropriate to explore the intrinsic or extrinsic orientation, and their interaction [8]. It is also important to emphasize that under the assumption that child have a strong need to demonstrate sporting dominance and if same child also have a lack of competence in the performance, there comes frustration and lack of motivation as a consequence [4], [7], [3]. In sports clubs, generating the positive motivational climate can be crucial, because research points to that as a predisposition for athletic success [7], [3].

Therefore, coaches and teachers of various motor activities have to compare the results in orientation of certain groups, such as recreational and competitors, to get a potentially fundamental guidelines for the control of educational and training process of young athletes. Accordingly, the fundamental objective of this study was to determine the existence of statistically significant differences in the level of EO and IO for recreational gymnasts and competitors. Aim is also within each group to analyze differences between EO and IO dimensions. A secondary objective of this study was to obtain referent values for young gymnasts in two observed dimensions. These results should generate important conclusions in terms of methodological and pedagogical guidance of young gymnasts, together with future modes of sport club organization, particularly targeting motivational climate. It should be noted that studies of this type are rare which gives preeminence to this study.

2. Hypotheses of the research

In accordance with the objectives of this research, following hypotheses are given: H1-Ego orientation will be significantly higher in gymnasts who train recreationally than competitors. H2-Competitors will have significantly higher task orientation than recreational gymnasts. H3-Competitors will have a significantly greater task orientation ego orientation. H4-Recreational gymnasts will have a significantly greater task orientation than ego orientation H5-Concerning all gymnasts together, there will be significantly higher task orientation than the ego orientation.

3. Methods

For this research, 69 young female gymnasts, aged between 7 and 12 years, members of the club "Salto" from Solin, Croatia were examined. Sample consisted of 43 girls from a group of recreational gymnasts (3 training per week) and 26 competitor gymnasts (4-6 trainings per week). Measuring instrument for assessing intrinsic and extrinsic orientation in sport is TEOSQ (Task and Ego Orientation in Sport Questionnaire) [6], [7]. TEOSQ consists of 13 questions (items), of which 7 of them refer to a task orientation dimension (items 2, 5, 8, 9, 11, 12, 13), and other 6 questions refer to ego orientation dimension. Furthermore, TEOSQ uses 1 to 5 Likert-type scale (1-strongly disagree, 5-strongly agree). For this research, Croatian version of the TEOSQ was used [1]. Same authors have checked the psychometric properties, factor structure and reliability of the Croatian version of the questionnaire TEOSQ.

For each item within each dimension (IO and EO) and for two subsamples and complete sample average value and standard deviation was calculated. In accordance with hypotheses of the research, one-sided t-test for dependent and independent variables was used.

4. Results and discussion

Table 1 shows average results of all used TEOSQ questionnaire items.

Table 1. Average values of items (N – sample size, M – mean, SD – standard deviation)

IO				EO			
ITEM	**N**	**M**	**SD**	**ITEM**	**N**	**M**	**SD**
P2	69	4.58	0.67	**P1**	69	2.97	1.47
P5	69	4.68	0.72	**P3**	69	3.30	1.34
P8	69	4.58	0.67	**P4**	69	2.36	1.37
P9	69	4.75	0.58	**P6**	69	2.39	1.34
P11	69	4.59	0.65	**P7**	69	2.97	1.38
P12	69	4.68	0.58	**P10**	69	3.26	1.30
P13	69	4.57	0.81				

If we look at the entire sample as a homogeneous entity, it can be seen that the values of the responses to representatives of the latent dimension IO is very high, over 4.5, while for the ninth item (P9) is even 4.75 (Table 1). Furthermore, the values of all answered question that measure latent dimension EO range from 2.36 to 3.26 and the mean is approximately 2.8. It is remarkable that the ego orientation in all subjects together, in absolute terms is lower than the task orientation, which is the expected result. Within table 2, average results for subsample consisted of gymnasts team members are given, separately for the IO and EO dimensions.

Table 2. Average values of items for team members – more successful gymnasts (N – subsample size, M – mean, SD – standard deviation,)

IO				EO			
ITEM	N	M	SD.	ITEM	N	M	SD
P2	26	4.69	0.62	P1	26	2.00	1.17
P5	26	4.77	0.59	P3	26	3.15	1.32
P8	26	4.54	0.71	P4	26	2.08	1.47
P9	26	4.77	0.71	P6	26	1.96	1.22
P11	26	4.42	0.81	P7	26	2.69	1.49
P12	26	4.85	0.46	P10	26	2.85	1.49
P13	26	4.54	0.95				

From Table 2 can be seen that the average results in the IO dimension is 4.65, which means that observed young competitors are highly oriented to the task. That fact is also verified trough results of all subjects together. The calculated values are expected and positive. Furthermore, the values of the responses of team members subsample in dimension EO is ranging from only 1.9 to 3.1, and the average of all particles is 2.45. Thus, we conclude that the contestants are not very focused on the high score what is expected result as also very positive result. Within table 3, average results for subsample consisted of recreational gymnasts are given, separately for the IO and EO dimensions.

Table 3. Average values of items for recreationally training gymnasts- less successful gymnasts (N – subsample size, M – mean, SD – standard deviation,)

IO				EO			
ITEM	N	M	SD	ITEM	N	M	SD
P2	43	4.51	0.70	P1	43	3.56	1.33
P5	43	4.63	0.79	P3	43	3.40	1.37
P8	43	4.60	0.66	P4	43	2.53	1.30
P9	43	4.74	0.49	P6	43	2.65	1.36
P11	43	4.70	0.51	P7	43	3.14	1.30
P12	43	4.58	0.63	P10	43	3.51	1.12
P13	43	4.58	0.73				

Furthermore, from Table 3 can be seen that the 43 gymnasts who are training recreationally highly oriented to the task. The average of the responses ranged from 4.5 to 4.7 and the mean of all responses was 4.62. Comparing the results with a group of team members it can be seen that the results are similar in absolute terms, although it was expected that they will be slightly lower. However, analyzing from the coaches aspect, for the whole sport organization and children themselves, it is better that this group have larger results in IO dimension. Also a group of recreational gymnasts, in terms of absolute values have lower results in EO dimension than in IO dimension (Table 3). But it have to be noted that the average response ranges from 2.5 to 3.5 and on average is 3.13 and that is relatively higher than in the group of competitors in IO dimension. Furthermore, in accordance with goal of this research - to determine and explain are there statistically significant differences between the results in the dimensions of the IO and EO for team members and those who train recreationally, within Table 4 results of one-sided t-test for dependent and independent variables are presented.

Table 4. Results of one-sided t test (t – t value, df – degrees of freedom, p – empirical significance of t-test)

Observed difference	t-test type	t	df	p
R-C in EO	Independent samples	-3.12	67	0.0027
R-C in IO	Independent samples	0.32	67	0.75
C in IO and EO	Dependent samples	11.96	50	0.0000
R in IO and EO	Dependent samples	9.98	84	0.0000
Total sample - IO and EO	Dependent samples	14.42	136	0.0000

Legend: **C**-team members, **R**-recreation

T-test results are presented in Table 4 indicate that a statistically significant differences in the task orientation between the contestants and recreational gymnasts. It is obvious that the contestants are much less focused on the result than recreational gymnasts. This result is in accordance with expectations since the successful gymnasts should be less focused on the result then less successful. We can conclude that hypothesis H1 is confirmed.

On the other hand, hypothesis H2 cannot be approved. Precisely, both groups are highly task oriented and consequently statistically significant differences in the dimension of IO were not found. This facts suggests the existence of positive motivational climate – both contestants, as well as for recreational gymnasts are focused on the task. Furthermore, from Table 4 it can be clearly seen that statistically significant differences exists between the dimensions of the IO and EO inside group of the contestants. Average value of task orientation was 4.65 and the ego orientation was 2.45 (Table 2) and thus hypothesis H3 is confirmed. It is also clear that significant differences exist between the dimensions of EO and IO in a group of recreational gymnasts. Similar to team members, differences are high in absolute terms - the result in the IO dimension is 4.62 and the dimension of EO is 3.13. This proves the hypothesis H4. Finally, looking at the total sample of 69 young female gymnasts, average results in the IO dimension is 4.63 and in the EO dimension 2.87 and statistically significant difference was found between these two orientations. Thus, hypothesis H5 is confirmed. This result was expected and desirable, especially due to the specificity of sport gymnastics. Regardless of group membership, motivational climate is directed same toward all children.

5. **Conclusion**

The results of this study clearly indicate that the population of young gymnasts is highly task oriented. More precisely, the dimension of the IO is prevalent in the group of contestants and in a group of recreational gymnasts, and of course, in all observed subjects together. This is probably due to the positive motivational climate and coach labor coach and it shows that already implemented coaching strategy should be used in the future. Comparing contenders as successful gymnasts and recreational gymnasts as the less successful it can be seen that the contestants actually had a lower ego orientation, but at the same time task orientation was very high. So, personal progress is important to all observed gymnasts and they invest the effort to achieve it. It is important to underline that selected children are not comparing themselves with others they set realistic goals and have greater confidence. Due to the sample used in this research, the results could probably be generalized to the population of young gymnasts. Future research should be based on the other sports, and more homogeneous samples of subjects. We assume that it would be of high professional and scientific interest to examine whether the correlation exists between IO/EO orientations dimensions with the overall efficiency and other sport-specific variables in a particular sport. These future studies, together with this research can be of great help to expert coaches in professional educational, pedagogical and kinesiological work especially in creating a positive motivational climate.

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IMAGE NOISE REDUCTION BY TOPSIS MEDIAN FILTER

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Abstract
This paper presents a mathematical model to generate noise in color images. Noises occur in: data transfer through the noised channel errors when storing in the memory, the various faults in the camera, changing the voltage, etc. The filter based on the TOPSIS method which selects between the positive ideal and the negative ideal solution, is presented for this purpose.

Keywords:
impulse noise, image processing, TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), MAE (Mean Absolute Error), MSE (Mean Squared Error), PSNR (Peak Signal-to-Noise Ratio), TMF (Topsis Median Filter)

1. Introduction

Increasing the visual information in multimedia, which appear in everyday life, causing the need to image processing, and this area has a topic of intense research in recent decades, particularly as regards color image processing. Reason for this are various failures of sensors, instability of the electronic signals, optical interferences, etc. All of them affect the image quality leading to the need its reconstruction. For this purpose they constructed different filters that remove different types of noise in the image. Since each pixel in the image presented as three-dimensional vector, where the components are respectively the intensities of red (R), green (G) and blue (B), designed a filter that works as follows. First, we define a sliding window as

$$W_{ij}=\left\{ f_{i+k,j+l} : |k-i| \le \frac{N-1}{2} \ \& \ |l-j| \le \frac{N-1}{2} \right\},$$

where $1 \le i \le l_1$, $1 \le j \le l_2$, and l_1, l_2 represent a dimension of the image. Number N represents a dimension of the sliding window, which is usually 3 or 5 (in the article is used 3×3 sliding window), centered around the pixel f_{ij}. Our goal is to replace the observed filter with the result of filter $\hat{f}_{ij}$ which acts on the set of pixels within the window W_{ij}. The filter is constructed so that a multiple criteria problem decision, which is solved by TOPSIS method (see [1]). It has been shown that the metric D_p TOPSIS method, a well-defined measures the filtering process. Repeating the procedure for each pixel within the picture gets a new reconstructed image. Because of the easier notation, the set of vectors within the window will be marked with $W_{ij} = \{x_i : i = 1, \ldots, n\}$ (see Fig.1).

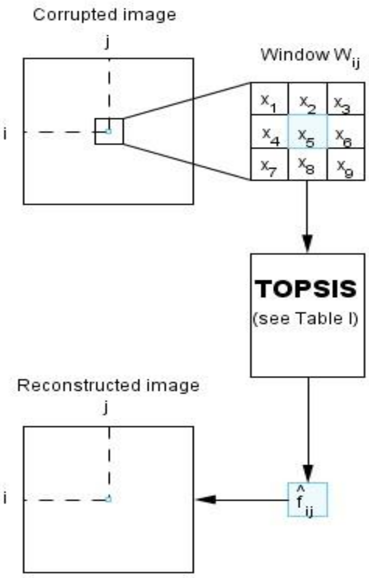

Figure 1. TMF Processing Scheme

2. Proposed Method

As we have reduced the problem of filtering in multicriteria task, for this purpose was constructed Decision Table (Table 1), where alternatives are consecutive pixels within the filtering window W_{ij}. Problem of filtering criteria were defined as the intensity of red, blue and green. The last criterion is the weights: $x_1^T = 1$, $x_2^T = 2{,}5$, $x_3^T = 1$, $x_4^T = 2{,}5$, $x_5^T = 6$, $x_6^T = 2{,}5$, $x_7^T = 1$, $x_8^T = 2{,}5$, $x_9^T = 1$. Given weights are used in [2] as the weights of WVMF (Weighted Vector Median Filter) that weight of an advantage in the process of giving filtering of neighboring pixels, thereby reducing the risk of replacing non-corrupted pixel in the filtering process. If the pixel is corrupted, the adjacent pixels, which best represent the observed pixel, will have an advantage in the process of filtering. In order to TOPSIS method adapted to our problem of image filtering, it is necessary to modify the *positive ideal solution* $A^* = (f_R^*, f_G^*, f_B^*, f_T^*)$ and *negative ideal solution* $A^- = (f_R^-, f_G^-, f_B^-, f_T^-)$ as it follows:

$$f_R^* = \operatorname*{med}_{x_i \in W_{ij}} x_i^R \ , \quad f_G^* = \operatorname*{med}_{x_i \in W_{ij}} x_i^G,$$

$$f_B^* = \operatorname*{med}_{x_i \in W_{ij}} x_i^B \ , \quad f_T^* = \max_{x_i \in W_{ij}} x_i^T = 6,$$

and

$$f_R^- = \max_{x_i \in W_{ij}} \left| f_R^* - x_i^R \right| , \quad f_G^- = \max_{x_i \in W_{ij}} \left| f_G^* - x_i^G \right|,$$

$$f_B^- = \max_{x_i \in W_{ij}} \left| f_R^* - x_i^B \right| , \quad f_T^- = \min_{x_i \in W_{ij}} x_i^T = 1 \ .$$

Then we choose such the pixel that is closest to the ideal solution A^*, and the maximum distance from the negative ideal solution A^-. It was shown that the metric of TOPSIS method

$$D_p(x_i) = \frac{d_p^-(x_i)}{d_p^*(x_i) + d_p^-(x_i)} \ , \quad p \in \langle 1, \infty],$$

where

$$d_p^*(x_i) = \left(\sum_{k \in S} w_k \left(f_k^* - x_i^k \right)^p \right)^{\frac{1}{p}},$$

$$d_p^-(x_i) = \left(\sum_{k \in S} w_k \left(f_k^* - x_i^k \right)^p \right)^{\frac{1}{p}},$$

where *S* = {*R*, *G*, *B*, *T* }, represents the good solution to the problem of filtering pixels. For the observed metrics will be used L_1 norm, respectively *p* = 1, because of its robust properties (see [3]), which come into play due to ”outliers”, which in our example are corrupted pixels. Since the decision table (Table 1) are the corresponding weights criterion, the question is how to determine them. Weights will be determined by looking at their convex combinations, or looking for weights that applies

$$w_R + w_G + w_B + w_T = 1,$$

where we take the equal influence of each channel, from which it follows that $w_R = w_G = w_B = \alpha$. Thus it follows that $w_T = 1 - 3\alpha$. The reason why we have to weights the criterion color channels take the same values that we used in experimental trials model noise which uniformly generates noise on each channel (see [1]). Thus, our problem is reduced to searching a variable α in Table 1 with which the system will maximize the decision to eliminate noise.

Table 1. Decision table

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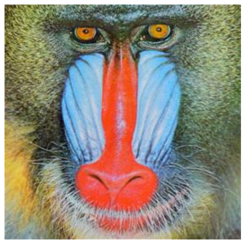
	w_R	w_G	w_B	w_T
Pixels	Red	Blue	Green	Weights
x_1	x_1^R	x_1^G	x_1^B	x_1^T
x_2	x_2^R	x_2^G	x_2^B	x_2^T
		...		
x_{n-1}	x_{n-1}^R	x_{n-1}^G	x_{n-1}^B	x_{n-1}^T
x_n	x_n^R	x_n^G	x_n^B	x_n^T

(a)



(b)

(c)

Figure 2. Representative images from the test set: (a) Lena (225×225 pixels), (b) Mandrill (262×262 pixels), (c) Parrots (275×183 pixels)

3. Noise Model and Error Metrics

The fact that every pixel in the image is presented as vector-valued signal, i.e. every pixel in $l_1 \times l_2$ size, no corrupted picture, it can be denoted as

$$x_{ij} = \left(x_{ij}^R, x_{ij}^G, x_{ij}^B \right), \quad 0 \le x_{ij}^R, x_{ij}^G, x_{ij}^B \le 255,$$

which represents the pixel on (*i, j*) position, where $1 \le i \le l_1$, and $1 \le j \le l_2$. In this paper, a widely used impulse noise model with the noise probability (or noise ratio) ρ is presented:

$$f_{ij} = \begin{cases} x_{ij}, & \text{with probability } 1-\rho, \\ \left(\xi_{ij}^R, x_{ij}^G, x_{ij}^B\right), & \text{with probability } \rho_1\rho, \\ \left(x_{ij}^R, \xi_{ij}^G, x_{ij}^B\right), & \text{with probability } \rho_2\rho, \\ \left(x_{ij}^R, x_{ij}^G, \xi_{ij}^B\right), & \text{with probability } \rho_3\rho, \\ \left(\xi_{ij}^R, \xi_{ij}^G, \xi_{ij}^B\right), & \text{with probability } \rho_4\rho, \end{cases} \quad (1)$$

where x_i represents the original and f_{ij} noise sample. When the image is contaminated by the fixed-valued impulse noise or "salt and pepper", the noise value $\xi_{ij}^C \in \{0,255\}$, $C \in \{R,G,B\}$ of a corrupted pixel is equal to 0 or 255 with equal probability. Consequently, it follows that $\sum_{i=1}^{4} p_i = 1$. In the simulations, the channel corruption probabilities were set to 0,25.

For the measurement of the restoration quality, the commonly used mean squared error (MSE) expressed through the peak signal to-noise ratio (PSNR), was used as the MSE is good measure of the efficiency of impulse noise suppression (the reason for this is sensibility of MSE on outliers which is represented in the paper as the impulse noise). The PSNR is defined as

$$\mathrm{PSNR} = 20\log_{10}\frac{255}{\sqrt{\mathrm{MSE}}}, \quad (2)$$

$$\mathrm{MSE} = \frac{\sum_{i=1}^{l_1}\sum_{j=1}^{l_2}\left\| x_{ij} - \hat{f}\right\|_2^2}{l_1 \times l_2}, \quad (3)$$

For the evaluation of the detail preservation capabilities of the proposed filtering design, the mean absolute error (MAE) has been used

$$\mathrm{MAE} = \frac{\sum_{i=1}^{l_1}\sum_{j=1}^{l_2}\left\| x_{ij} - \hat{f}_{ij}\right\|_1}{l_1 \times l_2}. \quad (4)$$

3. Parametre Selection

In this section, we will determine parameter α in Table 1 of TMF filter inside the sliding window W_{ij}, whose calculations-via the PSNR are given in Fig. 3, 4. It can be seen that $\alpha = 0{,}08$ achieves the best filtering results.

4. Comparison with State of the Art Filters

In this section, the proposed TMF filter is compared with several noise removal filters. The filters include VMF, BDVF, and DDF (see [5]). The objective results, for Mandrill, Lena, and Parrots example at 5 %, 10 %, and 15 %, evaluated by the commonly used measures such as MAE, MSE and PSNR are listed in Tab. 2, 3, 4. The given results show that TMF well removes impulse noise and preserves the best image details, which is evident from MAE.

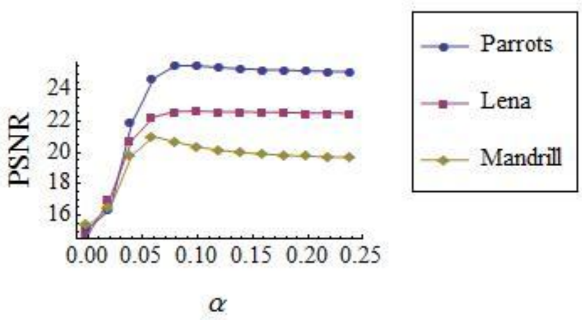


Figure 3. α versus PSNR at 10 % noise ratio

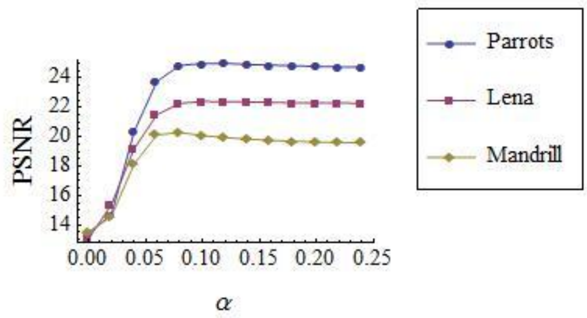


Figure 4. α versus PSNR at 15 % noise ratio

Table 2. Filtering results of Mandrill's example

	5 %		
Filter	MAE	MSE	PSNR
None	6,43	964,34	18,28
BDVF	37,04	1215,57	17,28
DDF	28,71	730,82	19,49
VMF	27,91	683,59	19,78
TMF	14,48	513,69	21,02
	10 %		
Filter	MAE	MSE	PSNR
None	12,41	1849,37	15,46
BDVF	37,65	1254,05	17,15
DDF	28,82	730,45	19,49
VMF	28,17	693,47	19,72
TMF	15,42	556,75	20,67
	15 %		
Filter	MAE	MSE	PSNR

None	18,99	2856,55	13,57
BDVF	38,07	126,2	17,11
DDF	29,18	746,31	19,40
VMF	28,57	707,99	19,63
TMF	16,54	607,45	20,30

Table 3. Filtering results of Lena's example

	5 %		
Filter	MAE	MSE	PSNR
None	6,15	1005,82	18,10
BDVF	15,95	473,63	21,37
DDF	12,97	324,05	23,02
VMF	13,3	320,91	23,06
TMF	6,87	289,82	23,51
	10 %		
Filter	MAE	MSE	PSNR
None	12,79	2128,86	14,85
BDVF	17,59	583,89	20,47
DDF	13,49	342,84	22,77
VMF	13,73	338,782	22,83
TMF	7,77	353,87	22,64
	15 %		
Filter	MAE	MSE	PSNR
None	18,97	3258,44	13,13
BDVF	18,58	621,73	20,19
DDF	13,96	357,39	22,59
VMF	14,04	348,56	22,70
TMF	8,60	384,66	22,28

Table 4. Filtering results of Parrots example

	5 %		
Filter	MAE	MSE	PSNR
None	6,48	1031,61	17,99
BDVF	9,45	254,43	24,07
DDF	7,50	196,24	25,20
VMF	7,71	192,04	25,29
TMF	3,63	173,87	25,73
	10%		
Filter	MAE	MSE	PSNR
None	12,37	1935,84	15,26
BDVF	10,11	275,66	23,72
DDF	7,72	199,44	25,13
VMF	12,37	194,60	25,23
TMF	4,03	8180,15	25,27
	15 %		
Filter	MAE	MSE	PSNR

None	18,42	2869,42	13,55
BDVF	10,87	308,82	23,23
DDF	8,08	208,58	24,93
VMF	8,07	201,48	25,08
TMF	4,69	212,10	24,86

5. Conclusion

We introduced a new TMF filter which suppres noise very well. We compare TMF with comonly used Filters were, and they were successfully tested using the well-known colour images with the widely used noise model.

9. Acknowledgement

The authors would like to thank everyone who contributed to achieving the realization of paper.

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APPLICATION OF WinCAM SYSTEM IN THE EDUCATION PROCESS

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Abstract
A short description of CAD/CAM systems used for programming of CNC machines, as well as the influence on the production processes, are given in this paper. The role of teaching the students how to use CAD/CAM systems (with special emphasis on CAM systems) is also explained. A classification of these systems is given from the standpoint of the historic development. The basics of CAM systems, as well as their application, are illustrated with an example of WinCAM system for the milling process. The typical steps from design of the workpiece to the machining are shown in the experimental part. After the designing of the workpiece in the CAD mode (with previously defined parameters in the CAM mode), and together with interactive work and simulation of machining in the WinCAM system by using the postprocessor, a milling program was generated for the control unit Sinumerik 810/820, on a chosen technological task.

Keywords:
Programming of CNC machines, WinCAM, milling

1. Introduction

In the last few decades, technology is developing and it significantly influences on the way of programming of CNC machines, since it is done by computers and by using various software. Production systems are developing and becoming more complex as technology develops. Since the first CAD/CAM systems appearance, and their integration with engineering work, new products with cost-efficient process are developed and produced more quickly. CAD (Computer Aided Design) – is the computer technology applied for designing the parts and creation of technical drawings. CAD packages, except from the geometric design, have been used for assembling of parts into a finished product, creation of technical documentation, analysis of the forces and loads, and various simulations. CAM (Computer Aided Manufacturing) – means using computer technology to assistance in the design, analysis and creation of a product, which can be realized with numerically controlled machine tools. Today's use of CAD/CAM systems is very widespread in all branches of production [1].

2. CAD/CAM systems

First-generation of CAD/CAM systems were developed in the early 60-ies at MIT (Massachusetts Institute of Technology) - it was the first CAD system called “Sketchpad“. The first CAM system was developed in 1957 and it represented a system for development of numerical – math instruction for machines in the technological process - named “Pronto“ [2].

The first CAD/CAM systems were used in some of the industrial branches such as automotive or aerospace, due to the high price of hardware. At the beginning of the 70-ies it comes to wider use of these systems as a result of falling prices of hardware with a significant increase in computer performance. This period is characterized by the significant development of various CAD/CAM systems such as UNIGRAPHICS, the Pro/Engineer, a ParaSolid, Solid-Works and the others.

Today's CAM systems can be classified into the two basic groups:

1. CAM systems that are part of the complex CAD/CAM/CAE systems (some of them are shown in Table 1).

Table 1. CAM systems as a part of complex CAD/CAM/CAE systems

CAD/CAM/CAE system	Producer	CAM mode represented in program
UGS	Unigraphics Solution	turning, milling, bending
CATIA	Dassault Systemes	turning, milling, casting, bending, mechanical processing
Pro/ENGINEER	Parametric Technology Corp.	turning, milling, bending, casting
Cimatron it	Cimatron	turning, milling, bending
I-DEAS	Structural Research Dynamic Corp.	turning, milling, bending

2. Specialized CAM systems. These systems can be classified as:
a) Complex CAM systems determined for computer supporting of more technologies, for example SURFCAM, SmartCAM, MasterCAM, etc.
b) Specialized CAM systems used for computer supporting of specific technology, for example PowerMILL, WorkNC, ECAM 350 and the other,
c) CAM superstructures of the specialized CAD systems, for example HyperMILL, CAMWorks and the others [3].

Programming in CAD/CAM systems is often achieved by the integration of CAD and NC mode using and transferring the data from CAD systems required for the creation of NC programs (usually using the IGES-Initial Graphics Exchange Specification files), or by the application of integrated CAD/CAM system characterised by the integrated processor and postprocessor of CAD system that enable adaptation to control unit of CNC machine [4].
Applying the CAD/CAM systems, a direct connection between design, technology and production is established. When connecting the CAD/CAM systems, the intention is that the technological representation (automatic determination of machining parameters, optimizations of operations…) be as much as possible [5].
In the phase of process planning and making the operational program for machining the parts on the CNC machine, by using the internal database of CAD data about geometry of the workpiece, it is necessary to download CAD data of the workpiece, to plan, program and simulate the production process [6].
As a result of the integration of CAD and CAM systems the more economical production of parts on a computer-controlled machines is provided, because it combines the process of designing the products and programming process which affects: increased productivity, faster product development, improved capability of solution analysis, reducing errors in design, obtaining data for automatic NC machines, reducing production costs, understandable drawings (isometrics, color…), better project management, and standardization of procedures for designing, drafting and documentation.
Research and development of new technologies are continuously incorporated into the teaching programmes and courses that comprise the programming of CNC machines and robots and the process planning. Theoretical and practical knowledge is given to the students through the educational process. It allows them to use a manual programming of CNC machines and the use of CAM systems and lead them towards the modern CAD/CAM systems.

3. EMCO WinCAM system for milling

WinCAM system is the complete product including CAD, CAM and NC, and it is possible to switch from one mode to another, any time. The system enables drawing the contour of the workpiece in the internal CAD mode with possibility of introducing already constructed workpiece in one of the CAD systems. The selection of necessary tools, defining all the processing parameters, and generating program code for the control unit of the selected CNC machine is performed in the CAM mode. Direct control of the selected machine occurs in NC mode. Figure 1 shows the concept of WinCAM system through the steps of designing workpiece to its production on the selected machine.

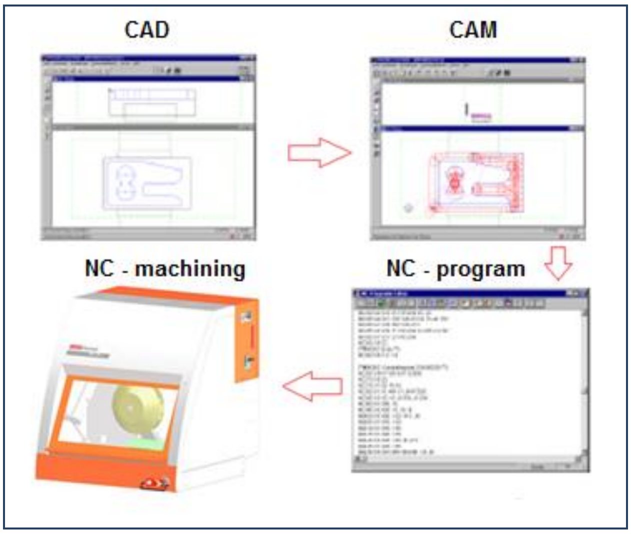

Figure 1. WinCAM data transmission

After the definition of raw material dimensions and position in clamping device, the active window is opening with the specified reference point, which represents a zero point for drawing the workpiece contour. The reference point is visible only in the active window and it's automatically placed in the lower left corner of raw material, respectively, in the upper left corner if the XZ plane is active, and it can move if necessary. After the selecting an appropriate function in the internal CAD mode it follows a drawing of the workpiece. In the CAM mode it is necessary to define machining parameters as well as the necessary tools selected from the tool base. In the machining menu a cycle can be selected (pocket milling with islands, follow contour, milling of circular and rectangular pocket, drilling, etc.), as well as the way of movement (rapid motion/operating feed). A group of commands „Periphery“ contains functions to activate the main spindle (in the direction clockwise / counterclockwise) and to stop it. The generated NC program is stored in the editor in which changes are possible and they are opened by selecting “Editor“ function. The CAM system is automatically updated after leaving the editor. Calling the “3D-View“ function it starts a 3D simulation by which the machining process is following, and it gets a warning about the collision, if it exists. Simulation offers the possibility of performing a block by block, and stopping at any time [7].

4. Experimental

The first step when working with EMCO WinCAM system is defining raw material dimensions and its position in the clamping device. Using a drawing tool in the CAD mode, designing the workpiece is done which is the base for further work in the CAM mode, shown in Figure 2.

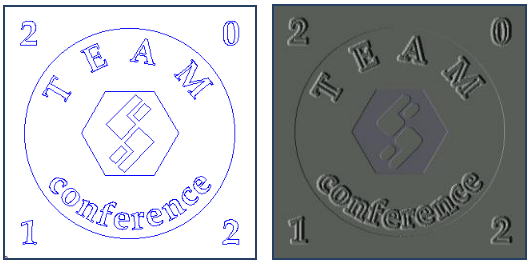

Figure 2. Workpiece

After creating the drawing, it follows defining an appropriate control unit (Sinumerik 810 M) for the selected machine, and the selection of necessary tools and machining parameters for each of the operations specified in technological process. By defining the machining parameters (feed rate, cutting speed and depth of cut…), switching the main spindle on and determination its direction of rotation, the machining can start. During the machining process a cycle for milling pocket with islands, the cycle for contour milling and engraving are used. The working process can be followed simultaneously in both planes, as shown in Figure 3.

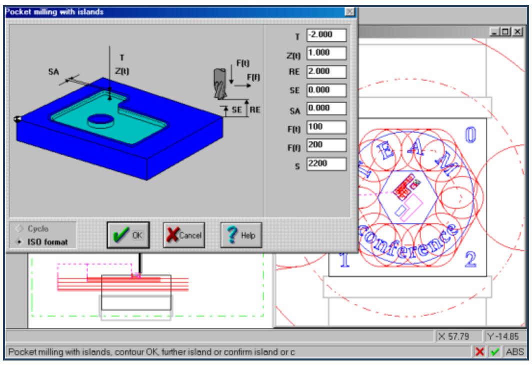

Figure 3. Machining in CAM mode of WinCAM

Based on the defined production process, the selected tool and cutting parameters, automatic generation of NC code is performing. Clicking on the command symbol “Editor“ a separate window that displays the NC program during machining is opened (Figure 4).

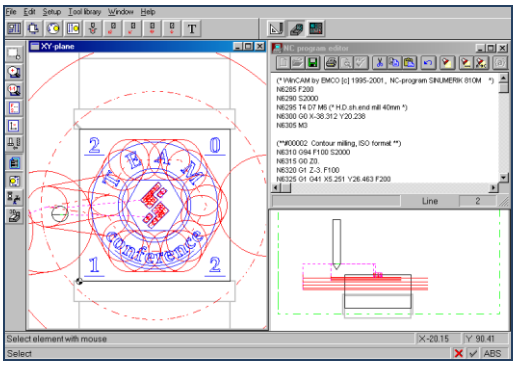

Figure 4. NC program during machining

Figure 5 shows a 3D simulation of the machining process for the selected technological task and the final shape of the workpiece in 3D.

Since, there was no warning about collision, the working process at the machine was safe to perform.

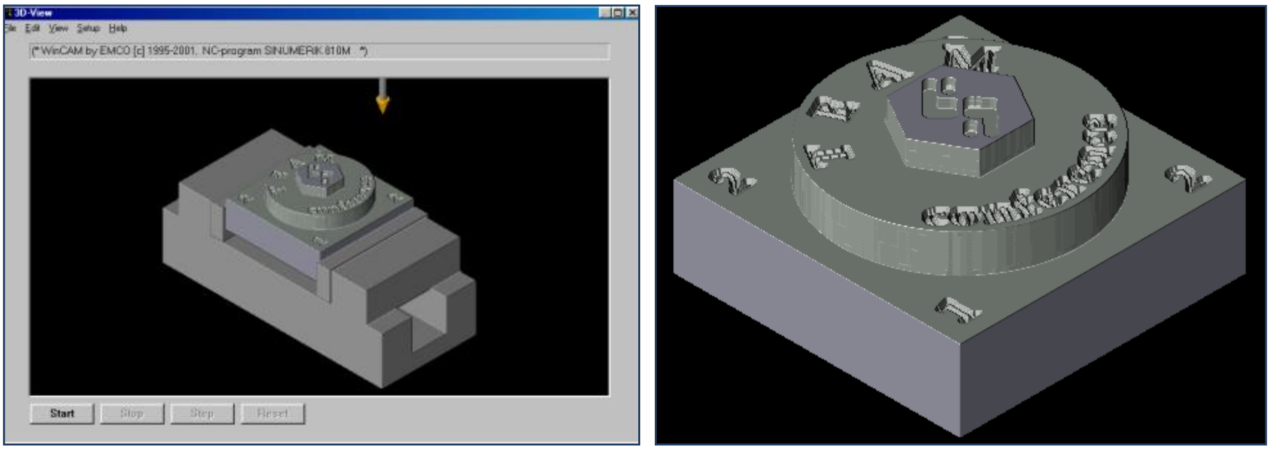

Figure 5. 3D simulation and workpiece in the WinCAM system

5. Conclusion

Development of production technologies has resulted in the development of new software to facilitate preparation and production of the product. Activities at programming CNC machines take up a significant part in the preparation of production. To make these activities cost effective and possible in some aspects of programming, CAD/CAM systems are introduced at manufacturing companies and provide faster, more quality and more efficient production. The process of teaching the students is created to enable studying the basics of programming using the education machines and gradually progress to modern – professional CAD/CAM systems. The paper gives an overview of using WinCAM system using the sample workpiece. Described system facilitates and accelerates the way of programming on CNC machines. The system provides automatic recognition of contour and using of cycles, as well as accessing the 3D simulation which helps to prevent eventual collisions during the process.

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OPEN SOURCE DOCUMENT MANAGEMENT SYSTEM IN PREPARATION OF EU GRANTS APPLICATIONS

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Abstract
In this paper we present our experience with selected open source document management system DocMGR in preparation of EU grants application. Complete lifecycle of the document management system is discussed: selection, installation, implementation and future replacement.

Keywords:
Document management, electronic documents, EU grants

1. Introduction

"Pari passu" – moving simultaneously, saying that well emphasizes how preparing applications for EU grants is synchronized and document oriented teamwork. One application for EU grant is usually prepared in a workgroup. The workgroup is always assembled from representatives of applicant; often it includes representatives from one or more partners and sometime representatives of associates. Although coming from different organizations, all members of the workgroup have to work in tight cooperation; therefore members must have access to the latest version of application's documents and must instantly receive notification about document changes.

Since EU government allowed access to EU grants for Croatian institutions, Mechanical Engineering Faculty in Slavonski Brod applied many times on grants' call for proposals. Faculty has always included partners and associates in application but it also contentedly accepted to be partner and associate in others applications.

Well established networked office organization model, which incorporated use of e-mail for communication and shared file system for storage, in previous cases resulted with data loss, unsynchronized documents and poor workgroup members awareness of changes in application documents. Therefore, new application workgroup model had to be established.

2. Requirements for more efficient workgroup organization model

Analysis of glitches in previous organization model yielded list of requirements for the new one. Some of them were dictated by limited budget. Fulfilment of requirements and higher workgroup efficiency would be achieved via implementation of appropriate software and new organization model.
List of requirements:

- Improved communication and collaboration in workgroup;
- Access to documentation from geographically diverse locations;
- Relatively low volume of documents, therefore, no requirement for extensive search and consequently, lowered need for metadata management;
- Implemented software should have steep learning curve i.e. has to be easy to master;
- Fine grained user roles and permissions;
- Check-in and check-out of documents;
- Reliable document altering signalization and alerting;
- Desirable document versioning and commenting;
- OS and Office software integration is welcome (WebDAV and Outlook integration);
- Low implementation cost;
- Simple maintenance and backup.

3. New organization model based on DocMGR

As limited budget purchase of expensive commercial software, along with commercial proprietary software, we considered use of open source software.
Some authors stated that Free and Open Source Software (FOSS) has its own economics [1] and many studies explain difficulties and provide reasons pro [2] et contra [3] of its use. However, although FOSS is covered by license and in its lifecycle some costs are certainly produced, it is free to use and initial investment in software is very low.
A number of groupware, document management and Enterprise Content Management (ECM) software solutions were taken into account.
Groupware or collaborative software by definition is software that enables workgroup collaboration and is part of Computer Supported Cooperative Work [4], [5]. Such software should be fine adjusted to nature and requirements of workgroup, but considered open source groupware e.g. phpGroupWare, SimpleGroupware, eGroupware, are all designed as general practice groupware and all are lacking document management features i.e. document meta-data, versioning,

check-in and check-out or pure user permission implementation.
Although some ECM systems are present on market for years, scientists didn't yet reach consensus on definition of this term [6]. Nevertheless, most authors do agree that ECM systems are dealing with organization's documents, and other content that is tightly related to organization's processes. Often, whole content lifecycle is processed.
Proven ECM systems like: Oracle ECM Suite, MOSS (Microsoft Office SharePoint Server), IBM ContentManager, Nuxeo, Alfresco, DSpace and others, being released as proprietary software or as SaaS (Software as a Service) and simultaneously satisfying almost all listed requirements, all have few demoralizing properties like:

- complex implementation planning,
- time-consuming implementation,
- relatively high hardware footprint,
- complex meta-data requirement,
- substantial expenses,
- necessity of well-trained users,
- complex maintenance,
- huge excess of features not always needed.

As a optimal solution, we established new organization model based on DocMGR - open source document management system backed up with use of free communication and scheduling tools e.g. Skype, social networks, on-line scheduling – Foodle (http://foodl.org).
Document management, or here EDMS (Electronic Document Management System) as subset of ECM, is dealing with document's lifecycle – from creation, usage, modification to, finally, archiving. It is expected that such systems include following basic features:

- Check in/Check out,
- Version management,
- Search management and
- Organizing documents.

4. DocMGR – open source document management system

DocMGR is web-based open source Document Management System [7] based on Linux, Apache, PostgreSQL and PHP (LAPP) or Windows, Apache, PostgreSQL and PHP (WAPP) platform (Figure 1).
Difference between LAPP and more common Linux, Apache, MySQL and PHP (LAMP) platform is in used Database Management System (DBMS). Instead of MySQL, DocMGR PostgreSQL. These abbreviations describe common web software stack: Linux (or Windows) server operating system. Apache web server software, MySQL or PostgreSQL DBMS and PHP web scripting language. Whole LAPP software stack consists of Free and Open Source Software (FOSS) software, so there was no initial investment in software.

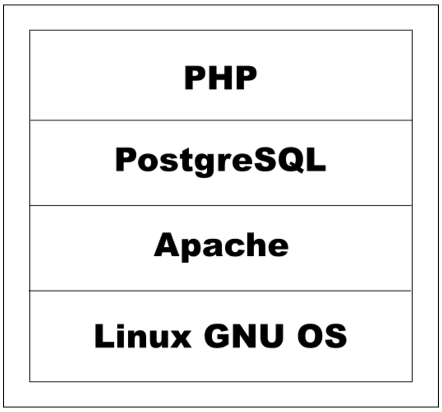

Figure 1. LAPP platform – Linux, Apache, PostgrSQL and PHP

Beside common document management features: Check in / Check Out, support for basic version management, search engine based on tsearch2 full-text indexing engine; it provides two convenient ways for document and folder (here called collections) organization: per user hierarchy and per project or topic hierarchy. Document security and user privacy and confidence are assured with user groups and user roles and fine-grained permissions system. Collection or documents (folder) as unit of document hierarchy or individual document, may be open for all users or may be assigned to particular user or user group and thus secured from abuse or unauthorized manipulation. Furthermore, for authorization and authentication external LDAP server can be applied.

Besides, DocMGR provides some extra document conversion, editing and compression features. On-line editing of various file formats is provided, mostly for plain text, Word, PDF as well for other popular file formats. On-the-fly conversion from popular formats as MS Power Point .ppt(x) to PDF, DocMGR format or ODF formats is also possible. Especially useful is, also, on-the-fly download and compression of collections, which saves time and bandwidth.

There are also some features usually present in groupware: Address book with possibility of sharing contacts, convenient e-mail application, simple task scheduling and workflow management. In addition, users can subscribe to alerts from collection: creating, modifying and deletion of object within collection. Finally, users can attach notes, comments and warnings to document or document version.

DocMGR user interface is simple and intuitive and allows almost instantaneous user adjustment. Screen real estate is optimally utilized, placing main menu on left side and most commands on top, thus leaving most of space for documents and documents listing (Figure 2)

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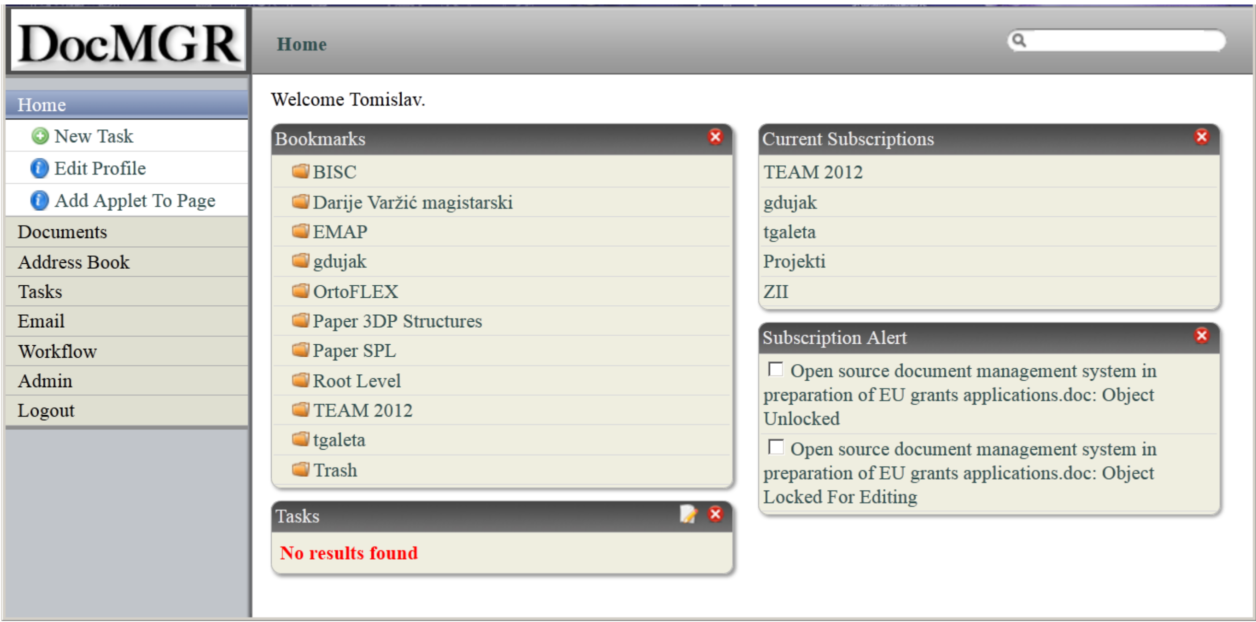

Figure 2. DocMGR user interface – main window

After using it more than two years, DocMGR proved to be low cost and low maintenance. LAPP platform can easily be implemented on commodity hardware but it will gain on performance if mid-class server is used. Particularly important is, as always, regularly backing-up database and whole server filesystem. In the specified time, there were no outages caused by software or platform itself. Just couple of outages was registered, mainly because longer power outages that wasn't covered by Uninterruptable Power Supply (UPS) and system resets because of need for implementing new Linux kernel. We had no data loss, file mislays or missing messages so we can confirm that DocMGR is highly reliable.

Contrary to popular belief that usage of Open - source software is risky, mostly because alleged lack of support, we were very pleased with achieved level of support. Several tiny problems that occurred were solved using software documentation and support forum, but additionally, in very beginning of using DocMGR, we contacted authors of software and reached agreement on an on-incident paid support. That kind of support was used just once, when software was going through major version revision and some fine tuning of database was needed. URL of our instance of DocMGR is http://doc.sfsb.hr/.

Statistical facts about DocMGR usage to date:

- 90 users distributed in 15 user groups logged 111000 times or about 150 times a day.
- 850 documents with 1130 document revisions occupy 4.4 GB of disk space.

Pros:
- Intuitive, easy to learn and master.
- Highly reliable. We suffered no data loss.
- Amazing level of support via forum and from software author.
- Low costs, small footprint and simple maintenance.

Cons:
- Slow response on large documents and relatively low limit on document size – limits inherited from platform e.g. PHP scripting language.
- Missing some features of ECM: automation of processes, DAM (Digital Assets Management), complicated and time-limited public access to documents, inability of connection with CMS software.
- Lack of comprehensive documentation.
- Croatian symbols glitches (solved via forum)
- Usual IE problems and pitfalls (solved via documentation and forums)

5. Conclusion

Chosen document management solution DocMGR with low cost, high reliability, small footprint and decent level of support, significantly logistically contributed to better workgroup organization, collaboration and efficiency. It overcame most of

deficiencies noted in previous workgroup organization model.
Next step to even better and efficient collaboration should be implementation of full-blown ECM system for institution, in private or public cloud. ECM should lead to better office software integration, administrative process automation, comprehensive archiving, DAM and tighter ties with CMS software.

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APPLICATIONS OF CONVEXITY ON RANDOM VARIABLE AND PARTICLE MECHANICS

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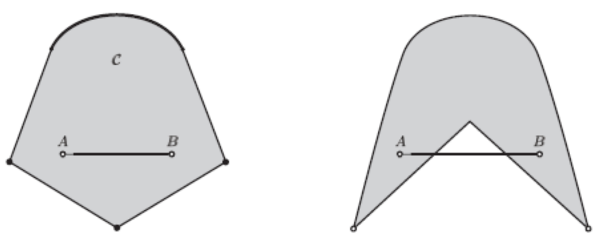
Abstract
The fundamental part of the paper refers to convexity in the space using the vector algebra. The applicable part refers to geometric properties of convex polyhedrons which are expressed by convex combinations of its vertices. Importance of convex combinations is shown in two applications: the expectation of discrete random variable and the center of particle mass.

Keywords
convex set, convex combination, radius-vector, polyhedron

1. Introduction

We recall the geometric description of a convex set in our three-dimensional space S. By this visual approach, a set $\mathrm{C} \subseteq \mathrm{S}$ is convex if for any two points $A, B \in \mathrm{C}$ the corresponding segment (line segment) $\overline{AB} \subseteq \mathrm{C}$. The convex and non-convex set are shown in Figure 1. Our aim is to express any point P from the convex set C by some boundary points of C. Boundary points which most protrude outward are called **extreme points**. The exact definition and the significance of extreme points can be found in [2]. The extreme points of the convex set in Figure 1 left, the three points and the arc, are bolded. Thus, for example, the extreme points of the convex polygon or polyhedron are its vertices. Simple and interesting visual properties of convexity can be found in [1].



Fiigure 1. Convex and non-convex set

2. Convex Combinations

Let's start with a segment with end-points A and B. If P is any point from the segment $\overline{AB}$, then $\overrightarrow{BP} = \lambda \overrightarrow{BA}$ where unique number $\lambda \in [0,1]$. Inserting radius-vectors considering some fixed point O, we get

$$\vec{r}_P = \lambda \vec{r}_A + (1-\lambda)\vec{r}_B. \tag{1}$$

In order to generalize the vector equality in (1), consider the expression

$$\vec{r} = \sum_{i=1}^{n} \alpha_i \vec{r}_i \tag{2}$$

with vectors $\vec{r}_i$ and coefficients $\alpha_i \in [0,1]$ such that $\sum_{i=1}^{n} \alpha_i = 1$. The expression in (2) is called **convex combination** of the vectors (position vectors of points or particles) $\vec{r}_i$ with the coefficients (numbers or scalars) α_i.

The aim of this section is to repeat the basic developing path in the application of convex combinations to the most important convex sets in the plane and space. The simplest convex sets in the line, plane and space are segment, triangle and tetrahedron, respectively. Using the notion of convex combinations and applying the vector algebra we get the three following basic propositions:

Proposition 2.1.1 (Segment Proposition) *Let $\overline{AB} \subset \mathrm{S}$ be a segment with end-points A and B. Then the vector equality as the unique convex combination*

$$\vec{r}_P = \alpha \vec{r}_A + \beta \vec{r}_B \tag{3}$$

holds for every point $P \in \overline{AB}$.

Proposition 2.2.2 (Triangle Proposition) *Let $\mathrm{C}(A,B,C) \subset \mathrm{S}$ be a triangle with vertices A, B and C. Then the vector equality as the unique convex combination*

$$\vec{r}_P = \alpha\vec{r}_A + \beta\vec{r}_B + \gamma\vec{r}_C \tag{4}$$

holds for every point $P \in \mathrm{C}(A,B,C)$.

Proof. Assisting with Figure 2 left, we find $\overrightarrow{CP} = \lambda\overrightarrow{CQ}$ where unique number $\lambda \in [0,1]$. Further, inserting the radius-vectors and applying the inequality in (3) on $\vec{r}_Q$, we get

$$\vec{r}_P - \vec{r}_C = \lambda(\vec{r}_Q - \vec{r}_C) = \lambda(\alpha_Q\vec{r}_A + \beta_Q\vec{r}_B - \vec{r}_C).$$

Arranging and putting $\alpha = \lambda\alpha_Q$, $\beta = \lambda\beta_Q$ and $\gamma = 1-\lambda$ in the above equality, we get the equality in (4). ∎

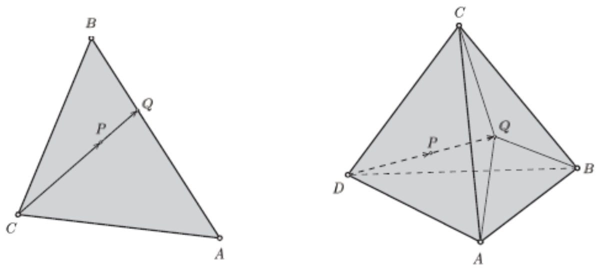


Figure 2. Points of triangle and tetrahedron as the convex combinations

Proposition 2.3. 3 (Tetrahedron Proposition) *Let $\mathrm{C}(A,B,C,D) \subset \mathrm{S}$ be a tetrahedron with vertices A, B, C and D. Then the vector equality as the unique convex combination*

$$\vec{r}_P = \alpha\vec{r}_A + \beta\vec{r}_B + \gamma\vec{r}_C + \delta\vec{r}_D \tag{5}$$

holds for every point $P \in \mathrm{C}(A,B,C,D)$.

Proof. Assisting with Figure 2 right, we find $\overrightarrow{DP} = \lambda\overrightarrow{DQ}$ where unique number $\lambda \in [0,1]$. Further, inserting the radius-vectors and applying the inequality in (4) on $\vec{r}_Q$, we get

$$\begin{aligned}\vec{r}_P - \vec{r}_D &= \lambda(\vec{r}_Q - \vec{r}_D)\\ &= \lambda(\alpha_Q\vec{r}_A + \beta_Q\vec{r}_B + \gamma_Q\vec{r}_C - \vec{r}_D).\end{aligned}$$

Arranging and putting $\alpha = \lambda\alpha_Q$, $\beta = \lambda\beta_Q$, $\gamma = \lambda\gamma_Q$ and $\delta = 1-\lambda$ in the above equality, we get the equality in (5). ∎

The basic convex sets in the plane and space are convex polygons and convex polyhedrons, respectively. Polygons are plane figures bounded by vertices and segments as edges. Polyhedrons are space bodies bounded by vertices and polygons. Applying the additional geometric observations of convex sets in the plane and space we achieve the following double theorem:

Theorem 2.4. 4(Polygon and Polyhedron Theorem) *Let $\mathrm{C}(P_1,\ldots,P_n) \subset \mathrm{S}$ be a convex polygon or polyhedron with vertices $P_1,\ldots,P_n$. Let $P \in \mathrm{S}$ be a point. Then the vector equality as the convex combination*

$$\vec{r}_P = \sum_{i=1}^{n}\alpha_i\vec{r}_i \tag{6}$$

holds if and only if $P \in \mathrm{C}(P_1,\ldots,P_n)$.

The Polygon and Polyhedron Theorem could also be imposed by using the set

$$\mathrm{C}(P_1,\ldots,P_n) = \left\{P \in \mathrm{S} \;|\vec{r}_P = \sum_{i=1}^{n}\alpha_i\vec{r}_i, \alpha_i \in [0,1], \sum_{i=1}^{n}\alpha_i = 1\right\}.$$

Remark 2.5. 5 *Convex combinations in (6) are not unique. For example, imagine that some point P from quadrangle $\mathrm{C}(A,B,C,D)$ belongs to the triangles $\mathrm{C}(A,B,C)$ and $\mathrm{C}(A,B,D)$, and P does not belong to the edge $\overline{AB}$. By Triangle Proposition, we have two different four-members convex combinations*

$$\begin{aligned}\vec{r}_P &= \alpha_1\vec{r}_A + \beta_1\vec{r}_B + \gamma_1\vec{r}_C + 0\vec{r}_D\\ &= \alpha_2\vec{r}_A + \beta_2\vec{r}_B + 0\vec{r}_C + \delta_2\vec{r}_D\end{aligned}$$

because $\gamma_1 > 0$ and $\delta_2 > 0$. Similarly, we can take pentahedron and apply Tetrahedron Proposition on suitable selected point from the observed pentahedron.

3. Expectation of Discrete Random Variable

One of the most general applications of convex combinations is just the one that refers to discrete random variables. For ease tracking we will assume that the random variable measures the temperature with respect to the unit where the temperatures are positive. So, let $P_1,\ldots,P_n$ be points in the space with temperatures $t_1,\ldots,t_n$. We want to determine the point P with expected temperature t_P. Take the total temperature $t=\sum_{i=1}^{n} t_i$, and the relative temperatures $\alpha_i = \dfrac{t_i}{t}$. It is reasonable to assume that the position vector $\vec{r}_P$ is the convex combination of the given position vectors $\vec{r}_i$, and the temperature t_P is the convex combination of the given temperatures t_i. Accordingly, we have the vector convex combination as the expected position (the center of temperature)

$$\vec{r}_P = \sum_{i=1}^{n} \alpha_i \vec{r}_i = \sum_{i=1}^{n} \frac{t_i}{t}\vec{r}_i,$$

and the scalar convex combination as the expected temperature (the arithmetic mean)

$$t_P = \sum_{i=1}^{n} \frac{1}{n} t_i = \frac{t}{n}.$$

If we want to accurately describe the geometric position of the point P, first we must determine the convex hull of all points observed, that is, the smallest convex polyhedron that contains all n points. Assume therefore that the points $P_1,\ldots,P_k$ are the vertices of convex polyhedron that includes all n points (see Figure 3). Assume that another points $P_{k+1},\ldots,P_n$ are also the vertices of convex polyhedron. Let

$$\alpha = \sum_{i=1}^{k} \frac{t_i}{t} \text{ and } \beta = \sum_{i=k+1}^{n} \frac{t_i}{t}$$

stand for the relative temperature of the first k particles and the relative temperature of the last $n-k$ particles, respectively. Note that $\alpha+\beta=1$. The expected point P belongs to the polyhedron with vertices $P_1,\ldots,P_k$ by Polyhedron Theorem. Using the formula for expectation in the radius-vector form, and separating it into two convex combinations, it follows

$$\begin{aligned}\vec{r}_P &= \sum_{i=1}^{n} \frac{t_i}{t}\vec{r}_i = \sum_{i=1}^{k} \frac{t_i}{t}\vec{r}_i + \sum_{i=k+1}^{n} \frac{t_i}{t}\vec{r}_i \\ &= \alpha \sum_{i=1}^{k} \frac{t_i}{\alpha t}\vec{r}_i + \beta \sum_{i=k+1}^{n} \frac{t_i}{\beta t}\vec{r}_i = \alpha \vec{r}_A + \beta \vec{r}_B\end{aligned}$$

where

$$\vec{r}_A = \sum_{i=1}^{k} \frac{t_i}{\alpha t}\vec{r}_i \quad \text{and} \quad \vec{r}_B = \sum_{i=k+1}^{n} \frac{t_i}{\beta t}\vec{r}_i$$

with

$$\sum_{i=1}^{k} \frac{t_i}{\alpha t} = \sum_{i=k+1}^{n} \frac{t_i}{\beta t} = 1.$$

So, $\vec{r}_P$ is the binomial convex combinations of $\vec{r}_A$ and $\vec{r}_B$ which are themselves the convex combinations of $\vec{r}_1,\ldots,\vec{r}_k$ and $\vec{r}_{k+1},\ldots,\vec{r}_n$, respectively.

4. Center of Particle Mass

We consider a set of n material particles in the space in order to specify the position of the center of mass. Let the particles be located at the points $P_1,\ldots,P_n$ with the masses $m_1,\ldots,m_n$. First we determine the convex hull of these points. Suppose that the points $P_1,\ldots,P_k$ are the vertices of the convex polyhedron containing all n points included (see Figure 3). Suppose another that the points $P_{k+1},\ldots,P_n$ are also the vertices of the convex polyhedron. Let

$$m = \sum_{i=1}^{n} m_i,\ \alpha = \sum_{i=1}^{k} \frac{m_i}{m} \text{ and } \beta = \sum_{i=k+1}^{n} \frac{m_i}{m}$$

stand for the total mass, relative mass of the first k particles and relative mass of the last $n-k$

particles, respectively. We have that $\alpha+\beta=1$. Let P stands for the location of the center of mass. Similarly as in the previous section, using the formula for the center of mass, and separating it into two convex combinations, it follows

$$\vec{r}_P=\sum_{i=1}^{n}\frac{m_i}{m}\vec{r}_i=\alpha\vec{r}_A+\beta\vec{r}_B$$

where

$$\vec{r}_A=\sum_{i=1}^{k}\frac{m_i}{\alpha m}\vec{r}_i \quad \text{and} \quad \vec{r}_B=\sum_{i=k+1}^{n}\frac{m_i}{\beta m}\vec{r}_i$$

with

$$\sum_{i=1}^{k}\frac{m_i}{\alpha m}=\sum_{i=k+1}^{n}\frac{m_i}{\beta m}=1.$$

We find that the position $\vec{r}_P$ is the binomial convex combinations of the positions $\vec{r}_A$ and $\vec{r}_B$. Similarly, the arithmetic mass mean m_P is the binomial convex combinations of the arithmetic mass means m_A and m_B, that is,

$$m_P=\sum_{i=1}^{n}\frac{1}{n}m_i=\frac{k}{n}m_A+\frac{n-k}{n}m_B$$

where

$$m_A=\sum_{i=1}^{k}\frac{1}{k}m_i \quad \text{and} \quad m_B=\sum_{i=k+1}^{n}\frac{1}{n-k}m_i.$$

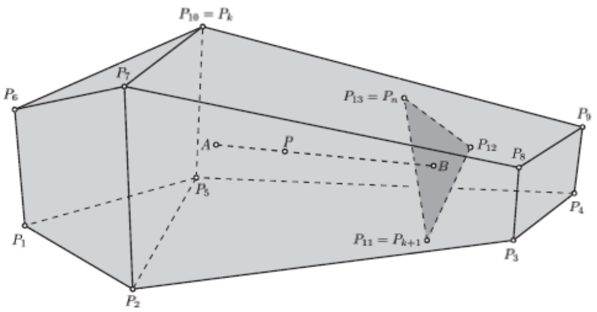


Figure 3. Expectation and center of mass as the convex combinations

Using the integral method the sequence of convex combinations pass into integral, so the center of mass becomes the barycenter. With the barycentres we can do the same as the convex combinations (see [3]).

5. Conclusion

In the practical sense the presence of convex combinations is evident in the formulation of important issues. Work with the convex combinations enables simple and general way of expressing. Expressions for the position of expectation and center of mass can be written as

$$\vec{r}_P=\sum_{i=1}^{n}\alpha_i\vec{r}_i$$

provided that $\alpha_i\in[0,1]$ and $\sum_{i=1}^{n}\alpha_i=1$, where $\alpha_i=\frac{t_i}{t}$ stands for the expectation, and $\alpha_i=\frac{m_i}{m}$ stands for the center of mass.

In the mathematical sense the observation of convexity in the space gives us an idea how to define this notion in any vector space. We have seen it all comes down to the convex combinations of vectors. We have also shown (Sections 3 and 4) that every convex combination can be reduced to the binomial convex combination. Following these findings we will say that a set C of a real vector space is convex if for any two vectors $a,b\in\mathrm{C}$ any its binomial convex combination $\alpha a+\beta b\in\mathrm{C}$.

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PHYSICAL INTERPRETATION OF CONVEX COMBINATIONS – DISCRETE AND INTEGRAL CASE

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Abstract

Convex combinations are applied in the positioning of the quantity center in the discrete case. Using the integral method we exceeded to continuous case, and applied integrals in the positioning of the quantity barycenter. Using the theory of measure it is shown that the quantity barycenter can be reduced to the set barycenter.

Keywords

convex combination, center of quantity, barycenter

1. Introduction

We recall the mathematical definition of convexity in the real vector space X. Let $x_1,\ldots,x_n \in \mathrm{X}$ be vectors, and $\alpha_1,\ldots,\alpha_n \in \mathrm{R}$ be coefficients. The vector expression

$$\sum_{i=1}^{n} \alpha_i x_i \tag{1}$$

is called **linear combination** of the vectors x_i with coefficients α_i. If the sum of all coefficients equals 1, then the linear combination is called **affine combination**. If additionally worth that all coefficients are non-negative, then the affine combination is called **convex combination**. So, the expression in (1) is convex combination if all $\alpha_i \in [0,1]$ and $\sum_{i=1}^{n} \alpha_i = 1$.

Set $\mathrm{C} \subseteq \mathrm{X}$ is **convex** if it contains all binomial convex combinations of its vectors. That means $\alpha x + \beta y \in \mathrm{C}$ for all $x, y \in \mathrm{X}$ and all $\alpha, \beta \in [0,1]$ such that $\alpha + \beta = 1$. Any convex combination with at least two positive coefficients can be expressed in the binomial form, that is,

$$\sum_{i=1}^{n} \alpha_i x_i = \alpha \sum_{i=1}^{k} \frac{\alpha_i}{\alpha} x_i + \beta \sum_{i=k+1}^{n} \frac{\alpha_i}{\beta} x_i \tag{2}$$

where $1 \le k \le n-1$, $\alpha = \sum_{i=1}^{k} \alpha_i > 0$ and $\beta = \sum_{i=k+1}^{n} \alpha_i > 0$. So, a convex vector set C contains all convex combinations of finitely many vectors from C. Convex hull $\mathrm{co}\mathrm{A}$ of a set $\mathrm{A} \subseteq \mathrm{X}$, as the smallest convex set which contains A, is determined by the set of all binomial convex combinations of vectors from A.

2. Physical Interpretation of Convexity – Discrete Case

We consider a set of n point particles in the space. Each particle presents the value of some physical non-negative quantity q like mass, density, potential, and so on. We want to specify the position of the center of quantity. Let the particles be located at the points $P_1,\ldots,P_n$ with the quantity values $q_1,\ldots,q_n$. Take the total quantity

$$q_{\mathrm{tot}} = \sum_{i=1}^{n} q_i. \tag{3}$$

Let P stands for the location of the center of quantity, and $\bar{q}$ stands for the quantity arithmetic mean. It is reasonable to assume that the position vector $\vec{r}_P$ is the convex combination of the given position vectors $\vec{r}_i$, and the quantity arithmetic mean $\bar{q}$ is the convex combination of the given quantities q_i. Accordingly, we have the center of quantity as the vector convex combination

$$\vec{r}_P = \sum_{i=1}^{n} \frac{q_i}{q_{\mathrm{tot}}} \vec{r}_i = \frac{1}{q_{\mathrm{tot}}} \sum_{i=1}^{n} q_i \vec{r}_i, \tag{4}$$

and the quantity arithmetic mean as the "scalar convex combination"

$$\bar{q} = \sum_{i=1}^{n} \frac{1}{n} q_i = \frac{q_{\mathrm{tot}}}{n}. \tag{5}$$

Example 2.1. ***(Particles in the Plane)*** *Let the particles $P_1,\ldots,P_n$ be located in the plane. First we determine the convex hull of these points, that is, the smallest convex polygon that contains all points. Suppose that the points $P_1,\ldots,P_k$ are the vertices of such convex polygon, and suppose another that the inside points $P_{k+1},\ldots,P_n$ are also the vertices of the convex polygon, as shown in Figure 1. Using the formula in (4) for the center of quantity, and separating it into two convex combinations, it follows*

$$\vec{r}_P = \sum_{i=1}^{n} \frac{q_i}{q_{\text{tot}}} \vec{r}_i = \alpha \vec{r}_A + \beta \vec{r}_B$$

where $\vec{r}_A = \sum_{i=1}^{k} \frac{q_i}{\alpha q_{\text{tot}}} \vec{r}_i$ and $\vec{r}_B = \sum_{i=k+1}^{n} \frac{q_i}{\beta q_{\text{tot}}} \vec{r}_i$

with $\sum_{i=1}^{k} \frac{q_i}{\alpha q_{\text{tot}}} = \sum_{i=k+1}^{n} \frac{q_i}{\beta q_{\text{tot}}} = 1.$

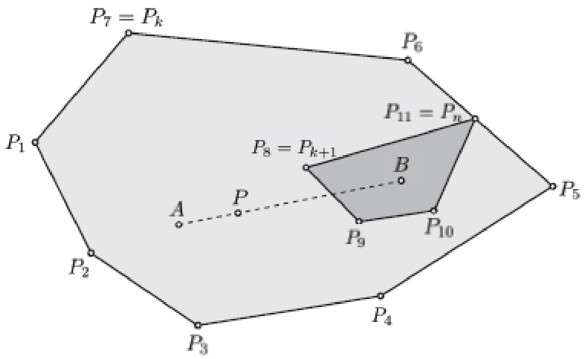

Figure 1. Center of quantity as the convex combination

We find that the position $\vec{r}_P$ is the binomial convex combinations of the positions $\vec{r}_A$ and $\vec{r}_B$. Similarly, applying the formula in (5) we get that the quantity arithmetic mean $\overline{q}$ is the binomial convex combinations of the quantity arithmetic means $\overline{q}_k$ and $\overline{q}_{n-k}$, that is,

$$\overline{q} = \sum_{i=1}^{n} \frac{1}{n} q_i = \frac{k}{n} \overline{q}_k + \frac{n-k}{n} \overline{q}_{n-k}$$

where $\overline{q}_k = \sum_{i=1}^{k} \frac{1}{k} q_i$ and $\overline{q}_{n-k} = \sum_{i=k+1}^{n} \frac{1}{n-k} q_i.$

3. Physical Interpretation of Convexity – Integral Case

We continue with observations in the plane. Now the particles are not separate, but we imagine that the particles form a continuous set. Let $\mathrm{A} \subseteq \mathrm{R}^2$ be a set, and $q : \mathrm{A} \to \mathrm{R}$ be a quantity as the function of two variables. Let $\vec{r}(x,y) = x\vec{i} + y\vec{j}$ be the radius-vector of the point (x,y). Given a positive integer n, the set A present as the union

$$\mathrm{A} = \bigcup_{i=1}^{n} \mathrm{A}_{ni}$$

where sets A_{ni} are pairwise disjoint, and every A_{ni} contracts to the point or vanishes in infinity as n goes to infinity. For every $i = 1,\ldots,n$ take $P_{ni} \in \mathrm{A}_{ni}$ as in Figure 2, $\vec{r}_{ni} = \overrightarrow{OP}_{ni}$, and $q_{ni} = q(P_{ni})$. Let $\mu(\mathrm{A})$ and $\mu(\mathrm{A}_{ni})$ stand for areas of the sets A and A_{ni}, respectively. Because we want to move on to an integral expression, we must take into consideration the set A and its subsets A_{ni}. Since the set A is the whole that contains all points $P_{ni} \in \mathrm{A}_{ni}$, the value q_{ni} will be replaced as follows:

$$q_{ni} \approx n \frac{\mu(\mathrm{A}_{ni})}{\mu(\mathrm{A})} q_{ni} = \frac{n}{\mu(\mathrm{A})} \mu(\mathrm{A}_{ni}) q_{ni}$$

We have the approximation for the total quantity:

$$q_{\text{tot}} \approx \sum_{i=1}^{n} q_{ni} = \frac{n}{\mu(\mathrm{A})} \sum_{i=1}^{n} \mu(\mathrm{A}_{ni}) q_{ni}$$

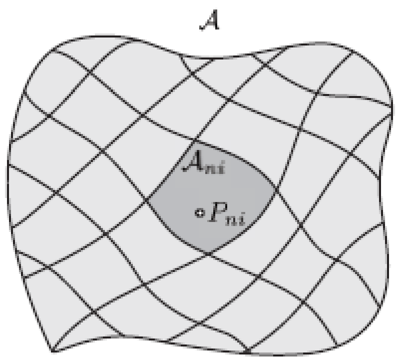

Figure 2. Division of the set

Substituting the adjusted values in (4), it follows:

$$\vec{r}_P \approx \sum_{i=1}^{n} \frac{\mu(\mathrm{A}_{ni}) q_{ni}}{\sum_{i=1}^{n} \mu(\mathrm{A}_{ni}) q_{ni}} \vec{r}_{ni} = \frac{1}{\sum_{i=1}^{n} \mu(\mathrm{A}_{ni}) q_{ni}} \sum_{i=1}^{n} \mu(\mathrm{A}_{ni}) q_{ni} \vec{r}_{ni} \qquad (6)$$

Letting n to infinity, the discrete formula in (4) gets the integral form:

$$\vec{r}_P = \frac{1}{\iint_{\mathrm{A}} q(x,y)dxdy} \iint_{\mathrm{A}} q(x,y)\vec{r}(x,y)dxdy = \frac{1}{\iint_{\mathrm{A}} qdxdy} \left(\vec{i} \iint_{\mathrm{A}} xqdxdy + \vec{j} \iint_{\mathrm{A}} yqdxdy \right) \qquad (7)$$

We used the double Riemann integrals in the above formula. So, the coordinates of the barycenter P of the quantity function $q(x,y)$ on the set A are:

$$x_P = \frac{\iint_{\mathrm{A}} xq(x,y)dxdy}{\iint_{\mathrm{A}} q(x,y)dxdy}, \quad y_P = \frac{\iint_{\mathrm{A}} yq(x,y)dxdy}{\iint_{\mathrm{A}} q(x,y)dxdy}.$$

If we put $q(x,y)=1$, then the expression in (7) presents the barycenter of the set A, that is, its radius-vector

$$\vec{r}_P = \frac{1}{\mu(\mathrm{A})} \iint_{\mathrm{A}} \vec{r}(x,y)dxdy. \qquad (8)$$

In the same way just before the discrete formula in (5) gets its integral form with the double Riemann integral:

$$\bar{q} = \frac{1}{\mu(\mathrm{A})} \iint_{\mathrm{A}} q(x,y)dxdy \qquad (9)$$

The expression in (9) is called the integral arithmetic mean of the quantity function $q(x,y)$ on the set A.

Theorem 3.1. *Let $\mathrm{A} \subset \mathrm{R}^2$ be a set with $\mu(\mathrm{A} > 0$, and $q : \mathrm{A} \to \mathrm{R}$ a quantity function such that $q(x,y) > 0$ for every $(x,y) \in \mathrm{int}\mathrm{A}$. If P is the barycenter of q on A, then*

$$P \in \mathrm{int}\left(\mathrm{co}\mathrm{A}\right).$$

In the proof of Theorem 3.1 we have to use the geometric description of a convex set. The geometrical characterization of convexity of the set A with $\mathrm{int}\mathrm{A} \neq \emptyset$ states that the line L through each point outside of $\mathrm{int}\mathrm{A}$ exists so that $\mathrm{L} \cap \mathrm{int}\mathrm{A} = \emptyset$, and $\mathrm{int}\mathrm{A}$ is contained in one of the half-planes determined by L. For more details see [1, pages 109-111]. Some properties of barycenters on the interval of real numbers have been studied in [2].

Theorem 3.2. *Let $\mathrm{A}_1, \dots, \mathrm{A}_n \subset \mathrm{R}^2$ be sets with $\mu(\mathrm{A}_i) > 0$, and $q_i : \mathrm{A}_i \to \mathrm{R}$ be quantity functions. If P_i are the barycenters of q_i on A_i, and P is the center of all quantities q_i, then*

$$\vec{r}_P = \frac{1}{\sum_{i=1}^{n} \iint_{\mathrm{A}_i} q_i(x,y)dxdy} \sum_{i=1}^{n} \iint_{\mathrm{A}_i} q_i(x,y)dxdy \vec{r}_i. \qquad (10)$$

Proof. Using the center quantity formula in (4) with the replacement

$$q_i \mapsto \iint_{\mathrm{A}_i} q_i(x,y)dxdy$$

gets the formula in (10). □

The center quantity formula in (10) affirms the radius-vector of the center of q as the convex combination of the radius-vectors of barycenters of q on A_i. From this center quantity formula follows the barycenter quantity formula:

Corollary 3.3. *Let $\mathrm{A}_1, \dots, \mathrm{A}_n \subset \mathrm{R}^2$ be pairwise disjoint sets with $\mu(\mathrm{A}_i) > 0$, and $\mathrm{A} = \cup_{i=1}^{n} \mathrm{A}_i$. Let $q : \mathrm{A} \to \mathrm{R}$ be a quantity function. If P_i are the barycenters of q on A_i, and P is the barycenter of q on A, then*

$$\vec{r}_P = \frac{1}{\iint_{\mathrm{A}} q(x,y)dxdy}\sum_{i=1}^{n}\iint_{\mathrm{A}_i} q(x,y)dxdy\vec{r}_i. \quad (11)$$

Proof. Let quantity functions q_i be defined as the restrictions of the function q on the sets A_i, that is, $q_i(x,y) = q(x,y)$ for $(x,y)\in \mathrm{A}_i$. Inserting these quantity functions in the formula in (10) gives the barycenter formula in (11). □

Puting $q(x,y)=1$ in the barycenter quantity formula in (11), we have the known rule for the barycenters of the sets:

Corollary 3.4. *Let $\mathrm{A}_1,\ldots,\mathrm{A}_n \subset \mathrm{R}^2$ be pairwise disjoint sets with $\mu(\mathrm{A}_i)>0$, and $\mathrm{A} = \cup_{i=1}^{n}\mathrm{A}_i$. If P_i are the barycenters of A_i, and P is the barycenter of A, then*

$$\vec{r}_P = \frac{1}{\mu(\mathrm{A})}\sum_{i=1}^{n}\mu(\mathrm{A}_i)\vec{r}_i. \quad (12)$$

Some results for barycenters on the intervals of real numbers are obtained in [2]. Everything we have done in the plane can be easily extended to the space.

By including the Lebesgue integral we can get more general expressions for barycenter and integral arithmetic mean of the quantity function q. Let μ be a measure on R^n. Let $\mathrm{A}\subseteq \mathrm{R}^n$ be a μ-measurable set with $\mu(\mathrm{A})>0$, $q:\mathrm{A}\to\mathrm{R}$ as $q=q(x_1,...,x_n)$ be a μ-integrable quantity function on the set A with $\int_{\mathrm{A}} qd\mu > 0$, and $\vec{r} = \vec{r}(x_1,...,x_n) = x_1\vec{i}_1 + ... + x_n\vec{i}_n$.

The barycenter P of the quantity function q on the set A may be presented by the radius-vector

$$\vec{r}_P = \frac{1}{\int_{\mathrm{A}} qd\mu}\int_{\mathrm{A}} q\vec{r}d\mu \quad (13)$$

provided that the functions $x_i q$ are μ-integrable on the set A.

The integral arithmetic mean of the quantity function q on the set A can be written with the fraction

$$\bar{q} = \frac{1}{\mu(\mathrm{A})}\int_{\mathrm{A}} qd\mu. \quad (14)$$

In the case of representing Theorem 3.1 by the Lebesgue integral, it is need to write $P\in\mathrm{coA}$ instead of $P\in\mathrm{int}(\mathrm{coA})$. Everything else that we presented with the Riemann integrals is also true with the Lebesgue integral.

4. Conclusion

In the theory of measure and integral the barycenter of the non-negative quantity q can be reduced to the barycenter of the set. Let the measure ν of the μ-measurable set A be defined by

$$\nu(\mathrm{A}) = \int_{\mathrm{A}} qd\mu.$$

It can be seen in [3, page 23]. Then the μ-barycenter of the non-negative quantity q on the set A corresponds to the ν-barycenter of the set A, that is,

$$\frac{1}{\int_{\mathrm{A}} qd\mu}\int_{\mathrm{A}} q\vec{r}\,d\mu = \frac{1}{\nu(\mathrm{A})}\int_{\mathrm{A}} \vec{r}\,d\nu.$$

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MOBILE AD-HOC NETWORK OF VEHICLES BY WIRELESS DISTRIBUTION SYSTEM

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ABSTRACT

This work examines the possibilities of maintaining a mobile ad-hoc network (MANET) by a Wireless Distribution System. We introduce and treat the performance limitations of this system regarding a MANET. In our case the MANET is considered to be a communication system of randomly moving vehicles, robot swarm or a group of people carrying mobile phones. A computer simulation study on the reliability of the wireless connection between a base station and the vehicles (or robot swarm) is given here. We measured the average broadcast time of a message from the base station while the vehicles are moving enclosed in a square shaped area. It was obtained that the average broadcast time is increasing dramatically when the linear size of the area exceeds the triple of the radius of the radio coverage.

KEYWORDS:
wireless networking, access point, WDS, MANET

1. INTRODUCTION

Wireless communication plays an important role in numerous swarm intelligence applications solved by mobile robots or autonomous distributed traffic controlling problems. Due to the considerable development in the field of swarm intelligence and multi-robot cooperation there are a wide variety of problems that can be solved efficiently by a group of autonomous robots or vehicles. In swarm robotics, for example, the most investigated tasks are the exploration of an unknown area [1,2,3] and the realization of some collective movement patterns such as gathering or chain formation [4]. In most of the cases the vehicles at hand are equipped with Wi-Fi (IEEE 802.11), Zig-Bee (IEEE 802.15.4) or Bluetooth (IEEE 802.15.1) radio systems, since they render cheap and yet satisfactory solutions for the communication between the autonomous agents. The Bluetooth system is economic and cheap but the most serious limitation of a Bluetooth network is that it is not scalable, since a Bluetooth piconet can consist of a master and at most seven slaves, and its radius of coverage is limited to ten meters [5,6]. If we have robots or vehicles big enough to supply a Wi-Fi Access Point (AP), the networking possibilities are better, since the Wi-Fi has a radius of coverage of 100 meters and is much more scalable than a Bluetooth network. In the following we examine theoretically the connectedness problems in a MANET of randomly moving vehicles with a fixed base station.

2. WIRELESS DISTRIBUTION SYSTEM

Connecting two or more wireless (distribution) systems can have several practical reasons. Wireless systems can most easily be created from Bluetooth or Wi-Fi networks. From previous publications [6] it is seen that the Bluetooth technology cannot provide coverage of suitable range, although it has low energy-consumption, which is important when implementing it on robots.

Due to the significance of range, the answer to the problem can be the Wi-Fi standard with a greater and higher quality range than of a Bluetooth solution – though with a bigger consumption of energy.

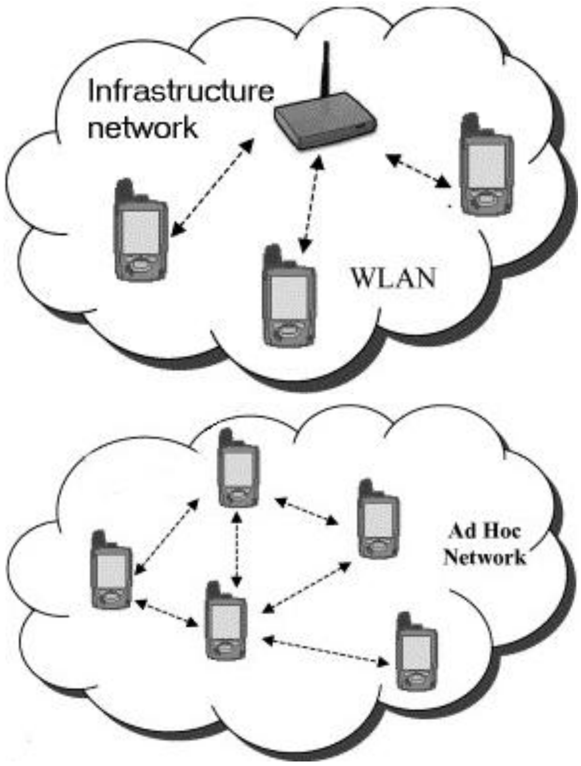

Figure 1. The Infrasctructure and the Ad-hoc network.

Network connections can be classified into two categories based on the type of connection (Figure 1.). One is the Ad-Hoc connection, where two devices connect to each other directly (without an AP). The other is, when more clients connect via an AP, the connection is called an infrastructure mode in a wireless network.

There are 3 well-known wireless network modes which enable clients and APs to connect to one sub-network. First, the Wireless Client Bridge mode, which, however, disables clients to connect directly to a wireless network and makes connection possible for a client only through a wired link to an AP. The second is the Wireless Repeater Bridge mode, where incompatibility problems (potential ARP problems) with certain programs or protocols (dependent on the MAC address) may occur due to the translation of the MAC address (Proxy ARP). The third is the WDS mode, which has the advantage of the WDS-method, that it is easy to create a continuous and long-range wireless network. The equipment on the vehicles (robots) (APs) not only connects to the Base Station in an infrastructure mode, but also transmits its signals to the other APs connected (SSID Broadcast) as a WDS Client. Thus, networks of arbitrary graphs can be formed without using any repeater.

To be more exact, any number of links (both wired and wireless) can connect to the points of the wireless backbone-network. For the installation of the WDS mode, all access points/devices to connect to the WDS master have to support the WDS client connection option.

Setting the WDS master:

- Select the WDS master mode in the menu of the wireless router.
- Set individual SSID network in the required field.
- Select an available radio channel.
- Note the MAC address of the WDS Master AP – it will be necessary during the setting of the clients.

Setting a WDS client:

- Select WDS client mode in the menu of the wireless router.
- Give the preset SSID in the required field.
- Give the preset channels of the WDS master.
- Give the MAC identification of the WDS master in the BSSID field.

From the encryption standards supported by the WDS, one can use the WEP and the WPA(1) standards. But irrespectively, one can use a MAC address filter, both for the connection points and the clients connecting to them. One should also consider the fact that in terms of WDS connections, the connection speed for communicating between two access points can only be the half of the connection speed of the access point at maximum.

Since the vehicles or mobile robots use little data exchange for communicating between each other, their requirements are profusely met by the wireless Wi-Fi.

3. COMPUTER SIMULATION AND RESULTS

With the help of a (MATLAB) computer simulation we evaluated the performance of the WDS regarding the connectedness in a MANET. The simulation consisted of ten APs, one WDS master and nine slaves. The master is considered to be a fixed base in the center of the simulated area. The other nine APs performed a random Brownian motion independently from each other but enclosed in the area. The magnitude of their speeds was constant and equal to each other in the linear parts of the Brownian motion.

We measured the broadcast time, while a message was spread in the network completely i.e. all of the nine mobile stations obtained the message. The delivery time was taken to be zero inside the ad-hoc wireless network connected momentarily to the base station. Obviously, not all of the APs will get the message at once; if the area is large enough, it can be a long time while an AP far from the base station is reachable. An explanation of the simulation environment can be seen in Figure 2.

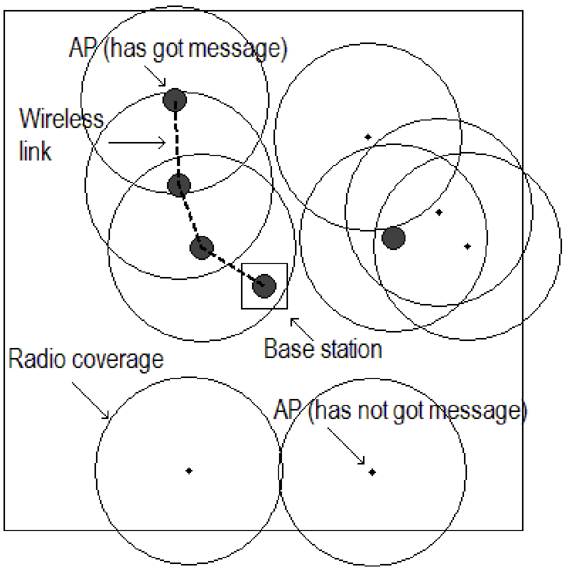

Figure 2. The MATLAB simulation of the MANET.

One hundred broadcast times were measured for each of the area sizes from 1.5 up to 5.5, where the area size was measured in the units of the radius of the radio coverage. The average broadcast times and their standard deviations were plotted as a function of the linear size of the area (Figure 3).

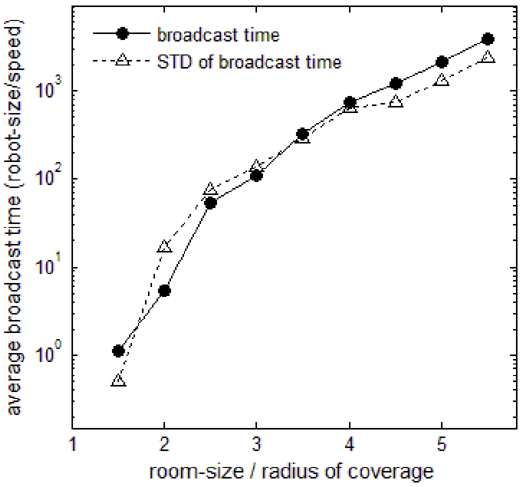

Figure 3. The average broadcast times and their standard deviation in a log scale as a function of the linear size of the area.

It can be seen that the broadcast time increases dramatically with the size of the area. When this size is comparable to the radius of the coverage, in most of the cases the APs form a complete connected network, so the broadcast time is close to zero. However, when the size of the area is raised to several times the radius of coverage, the total broadcast time increases to thousands of seconds (supposing one meter robot size and one meter/second constant wandering speed).

4. CONCLUSION

It can be concluded that if the working area is in the order of magnitude of the radius of wireless coverage, it is not necessary to apply additional algorithms to ensure connectivity. However when the area is bigger than 3-4 times this radius, then the application of such an algorithm ([7,8]) is essential.

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STRATEGIC MANAGEMENT FOR ICT USAGE IN EDUCATION

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Abstract

The use of communicational technology in education is an important component in quality education, development and employment in a competitive market. The educational system must meet the needs and overcome the challenges of an IT society and accept the benefits information and communication technology offers concerning availability of information and the posibility of life-long learning and education. Information and computer literacy today is as important as traditional literacy and in view of this the system must make certain adjustments to accomodate these new needs.

Keywords:
Educational system; IC technology;management;

1. Introductory thoughts

Croatian education has long been aware of the importance of ICT. Inspite of the fluctuations in educational policy concerning ICT, Croatian schools have been provided with the necessary equipment. Schools have internet connections, local networks, web pages and ICT is being used in the day to day operations of schools. Of course there are still many open questions on how to maximize the efficiency of this technology in the educational process. Strategic and well thought out development of the Croation educational system with the help of ICT in schools can contribute to the quality of the system that produces competetive knowledge base for further development of the Croatian economy.

2. International experience in strategic management for ICT usage in education

Legislation in over half of the euro zone countries recognise ICT as a key competency that teachers need to acquire during their initial education. In other countries instutions of higher education independently decide whether to include ICT or not. In fact, all countries except Denmark and Iceland cite teacher computer skills as a part of the continuing professional development programme (CPD). However, international studies TIMSS 2007 show a limited percantage of participation of teachers in CPD activites that focus on integrating ICT in to maths and natural sciences on a highschools level and a lower percentage on a grade schools level. (Eurydice)

3.The Croatian educational system and information technology

The National Commity for Competitiveness announced in april 2012 the results of a recent study by the World economics Forum (WEF) about information technology in which Croatia was ranked 45th of 142 countries when it came to ICT competitiveness. With more recent initiatives, plans and legislature along with streamlining existing legislature with EU laws, the government, the Ministry of Science, Education and Sport and other organisations have set guidlines for development that will increase the importance of education and will guide the Croation educational system in line with European and international trends. A widespread use of ICT in the government, among educational managers and schools is hindered by a rapid development in technology. Educational studies show that professional development programmes for teachers are most effective if they are tied in with development of the use of ICT in schools. The basic infrastructure for the use of new technology in the educational and research sector in the Republic of Croatia and the Ministry of Science, Education and Sports is developed and maintained by the Croatian academic and research network CARNet and University calculation Centre „Srce“. The law on upbringing and education in grade and high schools states the professional training in all segments including the use of ICT of its' teaching staff as a necessity. The results of the grade school teaching staff in Brod-Posavina County can be considered indicative of the acheived level of IT literacy.

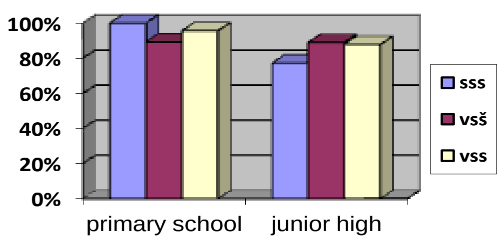
4. The Importance of Implementing a Strategy to improve the Quality of Education

Formulating and implementing a strategy in education are key activities and functions in management and a successful strategy as well as implementation are the surest signs of good management. A quality strategic management is essential to the long term success of an organisation. It points the organisation to the future, anticipates and makes changes and acts proactively which in these business conditions is becoming a prerequisite for development but also a necessity for survival.
With this in mind a strategy for the development of human potential has been developed in the Brod-Posavina county which among other goals plans to modernise the the educational system and upgrade the knowledge and skills of the workforce in using ICT.

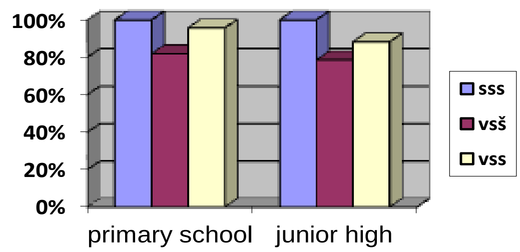
One of the key functions of management in education and school management is to secure the right staff, educate them, motivate and professionally develop them so they can contribute to acheiving the goals set. (Staničić, 2003.str.293. i d.)

5.Research results in basic IT knowledge of teaching staff in grade schools in Brod-Posavina County

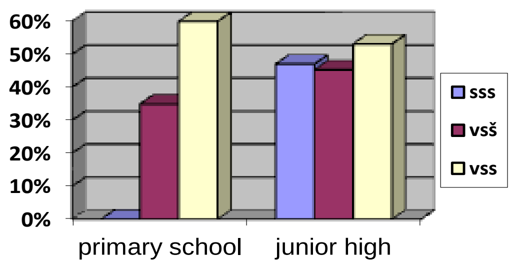
Research on basic computer literacy of the teaching staff was carried out in February 2012 in all grade schools in Brod-Posavina county which were founded by the county (23 grade schools) and the city (10 schools). Grade schools in the county have in total 1810 employees of which 1254 are teaching staff, 151 are professional staff, 336 professional staff, 34 staff in accounting and 35 in administration. These schools have 14.752 students from 1st to 8th grade in 771 classes. Research shows IT literacy among the teaching staff in Brod-Posavina county in 2012 that can be seen in graphs 1.2.3.and 4.



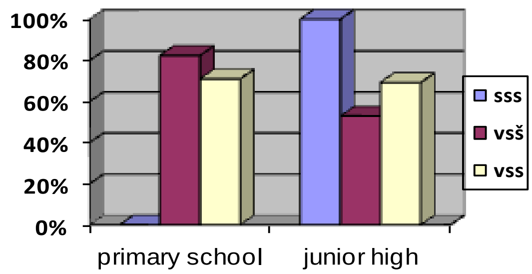
Graph1: Handing datafiles (MS Explorer, creating and opening files and so



Graph 2: Using text programmes (MS Word,..)



Graph 3: Using tables with table accounting (MS Excel,…)



Graph 4: Using presentation creation programmes (MS PowerPoint,..)

Results show that not all teachers in grade school have the competencies in basic IT operations and that additional IT training is needed. The teaching staff in grade and high schools show a low level of IT literacy and as such can not use IT in the classroom.

6. Conclusion

If we want to use ICT as an effective educational tool we must monitor and evaluate indicators that will help us increase the efficiency of ICT usage in promotion of innovation in the educational process. The use of ICT effects the creative development and digital competence of the students which is a priority for the EU's Education and Training 2020 strategy.Successful international organisations have focused on educating and developing the skills of their employees to advance their business and to develop and grow. Realisation of an organisational strategy is only possible if the employees possess the skills and knowledge ned to carry the strategy which means that education and development have become strategic goal in contemporary organisations.

Research carried out in Brod-Posavina county indicates that despite the commitment to ICT in educational institutions as well as the introduction of ICT in to the educational process efficiency can not be acheived becuase the teaching staff is not completely literate in ICT.

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KANSEI ENGINEERING – APPROACH OF AFFECTIVE DESIGN FROM THE EAST

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Abstract
This paper presents Kansei Engineering Method. This method is developed in Japan, and can be considered as a part of affective engineering or emotional design. This method is important because it can translate feelings and impressions in forms and characteristics of products. Also, in this paper is described common model which cover contents of Kansei Engineering and its application area.

Keywords:
Kansei engineering,, Kansei words, feelings, impressions, domain of products, semantic space, space of properties, synthesis, validation

1. Introduction

Kansei engineering (Japanese: kansei kougaku, an area of emotional / affective engineering) is a method for translating feelings and impressions into product parameters [2], invented in the 1970s by Professor Mitsuo Nagamachi (Hiroshima International University). Kansei engineering is such method that it can measure the feelings and shows the relationship to certain product properties. In consequence, product can be designed to bring forward the intended feeling [4].
The Japanese expression Kansei is difficult to translate. It means approximately “total emotions”, but that does not fully explain it’s meaning – in fact not more than partly. Kansei is the impression somebody gets from a certain artifact, environment or situation using all their senses of sight, hearing, feeling, smell, taste as well as their recognition [2] [3].

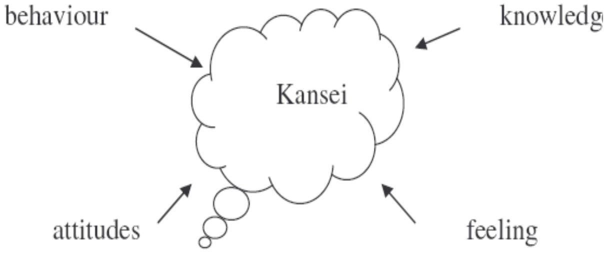

Figure 1. The Kansei in principle [2]

The design of products on today’s markets often become increasingly complex since they contain more functions and they have to meet more demands on e.g. user friendliness, manufacturability and ecological consideration. Shortened product life cycles are likely to increase development costs. This contributes to making errors in estimations of market trends very expensive. Companies therefore perform benchmarking studies that compare competitors on strategic, process, marketing and product level. Also, they need a reliable instrument, which can predict the products reception on the market before the development cost gets too critical. Success in certain market segment does not only require knowledge about the competitors and their products performance, but also about the impressions the product make on the costumer. This requirement becomes much more important the more mature the products and the companies are. This means that the costumer purchases a product based on more subjective terms such as manufacturer image, brand image, reputation, design, impressions, etc., although the products seem to be equal. A large number of manufacturers have started development activities to consider such subjective properties so that the product expresses the company image. The demands of such kind triggers the introduction of a new of a new research field dealing with the collection of costumer´ hidden subjective needs and their translation into concrete products. This kind of approach is done foremost in Asia, namely Japan and Korea, and in later stage in Europe, where is known as a new research field – „emotional design“ or „affective engineering“

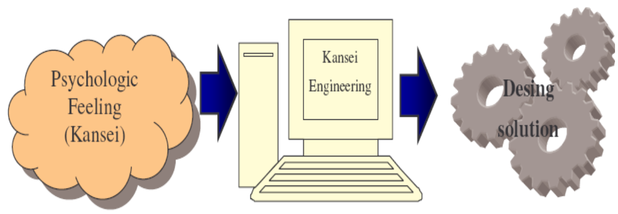

Figure 2. Kansei engineering [2]

People want to use products that should be functional at a physical level, usable at a

psychological level and should be attractive at a subjective, emotional level. Affective engineering is the study oft he interactions between the costumer and the product at that third level. It focuses on the relationships between the physical traits of product and its affective influence on the user. Thanks to this field of research, it is possible to gain knowledge on how to design more attractive products and make costumers satisfied.
Kansei method can be considered as a part of research field of affective engineering. Shimitzu at al. State that „Kansei Engineering follow identification products properties and relationship this properties and product design“ [1].

2. General model of kansei engineering

In Japanese publications, different types of Kansei Engineering are identified and applied in various contexts. Simon Shütte examined different types of Kansei Engineering and developed a general model covering contents of Kanse Engineering. Kansei engineering procedure is presented on picture bellow.

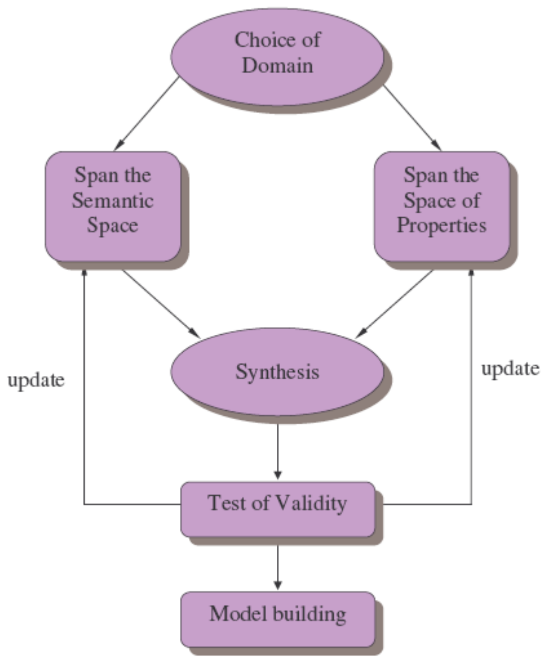

Figure 3. Kansei engineering procedure [2]

Choice of Domain – „Domain“ in this context describes the overall idea behind an assembly of products, i.e. the product type in general. Choosing the domain includes the definition of the intended target group and user type, and group of the product in question. Choosing and defining the domain is carried out including existing products (products can be tangible or intangible sample), concepts and as yet unknown design solution. From this, a domain description is formulated serving as a basis for further elevation.

Conclusion is that the task in this first step is to define the domain and find representatives (products, drawings, samples, etc.) covering the domain as good as possible [2].

Span the Semantic space – The expression „Semantic Space“ suggest that every artifact can be described in a certain vector space defined by semantic expressions (words). That can be done by collecting a large number of words that describe the domain. The sources for the choosing words are literature, manuals specification lists, expert interviews, user opinion and so on. The number of collected words varies, depending on the product between 100 and 1000 words. In second step the words are grouped using manual (i.e. Affinity diagram) or mathematical methods (factor and/or cluster analysis). Finally, a few representing words are selected from this spanning the Semanting Space. These words are called Kansei words. They are integrative part of an ongoing product

development process. However, the usage is limited in time. As trends shift, products change and techniques push foreword, the Kansei word database has to be checked and updated.

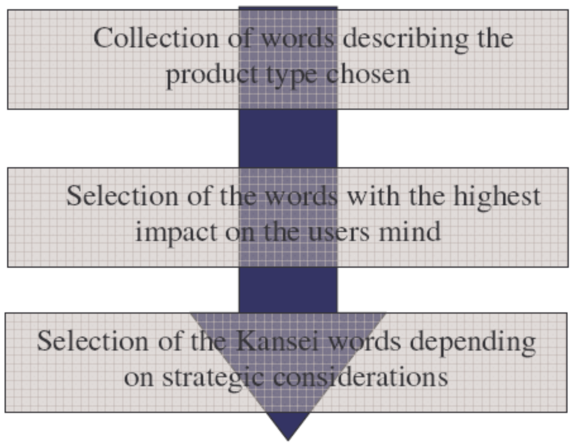

Figure 4. Span the Semantic space [2]

Span the Space of Properties – this step is similar to previous step of the Semantic space. The Space of Properties collects products representing the domain, identifies key features and selects product properties for further evaluation. The collection of products representing the domain is done from different sources such as existing products, costumer suggestion, possible technical solutions and design concepts etc. The key features are found using specification lists for the products in question. To select properties for further evaluation, a Pareto diagram can assist the decision between important and less important features. Compared to other methods in Affective Engineering, Kansei Engineering is the only method that can establish and quantify connections between abstract feelings and technical specifications. For every Kansei word a number of product properties are found, affecting Kansei word.

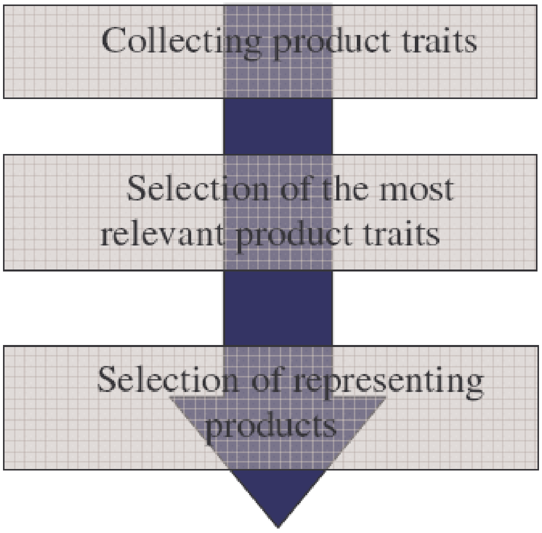

Figure 5. Span the Space of Properties [2]

The Synthesis phase – The probably most important step, which makes Kansei Engineering unique is it ability to connect the describing words (Kansei words) with the properties of the product. In difference to most alternative methods, the necessary data is gathered directly from the customers and evaluated mathematically. This decreases the risk of inaccurate results, since no subjective interpretation is used. The figure below illustrated the substance of the synthesis step [2].

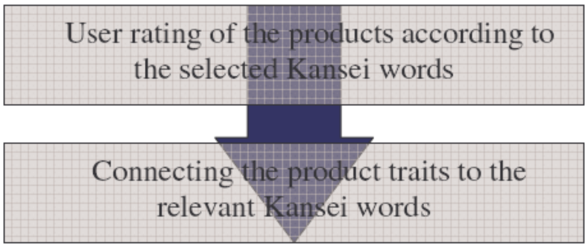

Figure 6. The Synthesis phase [2]

Model building and Test of Validity – after doing the necessary stages, the final step of validation remains. This is done in order to check if the prediction model is reliable and realistic. However, in case of prediction model failure, it is necessary to update the Space of Properties and the Semantic Space, and consequently refine the model. The process of refinement is difficult due to the shortage of methods. The existing tools can partially be found in the previously mentioned methods for the synthesis.
Theoretically this procedure can also be used for determining which of the product properties is obsolete, but this has not been tested yet.

3. Kansei engineering software

Software tools for Kansei engineering has always been advanced statistical and mathematical methods. Large number of this tools demand expert knowledge and considerably amount of experience for successful execution of tasks. In order to facilitate application some software packages have been developed in the recent years, most of them in Japan. There are two different types of software packages available: user consoles and data collection and analysis tools. User consoles are software programs that calculate and propose a product design based on the users subjective preferences. However, such program require a database that quantifies the connections between Kanseis and the combination of product attributes. For building such databases, data collection and analysis tools can be used.
There are many more tools use din companies and universities, which might not be available to the public. Kansei data collection and analysis is often complex and connected with statistical analysis.
Depending on which synthesis method is used, different computer software is used. Kansei Engineering Software (KEOs) uses QT1 for linear analysis. The concept of Kansei Engineering Software (KEOs) from Linköping University in Sweden generates online questionnaires for collecting of Kansei row data.
Another Software package (Kn6) was developed at the technical University of Valencia in Spain. Both software packages improve the collection and evaluation of Kansei data. In this way even users with no specialist competence in advanced statistic can use Kansei Engineering.
There are quite large number of others tools and methods such: Category Identification, Regression Analysis/Quantification Theory Type I, Rough Sets Theory, Genetic Algorithm, Fuzzy Sets Theory and so on. Which tool to use can depend about context, because feelings and emotions do not always follow mathematical rules.

4. The application of Kansei Engineering

Nowadays there are about 1000 professionals working with KE merely in Japan; approximately 100 of them professors, and approximately 300 engineers in several companies [2].

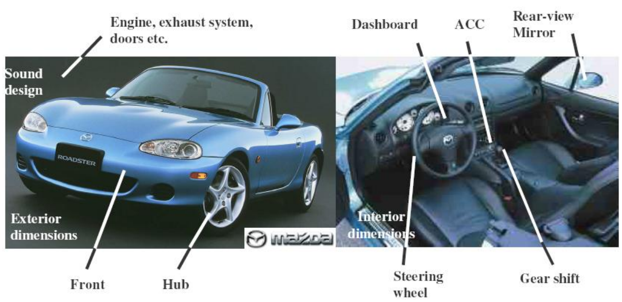

Figure 7. The Mazda MX5 an Example of applied Kansei Engineering

A number of products foremost in Japan have been developed with support of Kansei Engineering. One of the most famous examples is probably the Mazda Miata (MX5 in Europe). During its design process Kansei Engineering was constantly deployed to a great number of details. The goal was to achieve a concept where the driver feel as unit with the car [2]. The figure above shows some features developed using Kansei Engineering. In the 2001 this car was the worlds most sold sports coupe.
A lot of other well known manufacturers have successful adapted Kansei Engineering, for example Delphi Automotive Systems, Ford, Honda, Hyundai, Mazda, Mitsubishi, Toyota, Komatsu, Matsushita, Matsushita Electric Works, LG, Sanyo, Sharp, Samsung (home appliances), Canon, Fuji Film, Fuji Xerox, Kansai Electric Powerplant, Matsushita Electric Works, Tateyama Aluminum (electric industry), Goldwin, Wacoal (textile industry), Ogawa Fragrances, Noevia, Milbon, Shiseido (cosmetic industry).
Above mentioned company are from Asia, because Kansei method did not expand in Europe and USA in full extent (partly because of culturological reasons). In Europe there are two strong canters of Kansei Engineering – University in Linköping with its Kansei Engineering research group, which with its expanded activity has influence on Swedish industry, and Valencia University in Spain.

5. Conclusion

Design and development of new products and product concepts has always been a challenge for companies on their markets. Internationalization, technological development and economical pressure contribute to an increasing competition on in practice all international markets. An increased number of products available sometimes in combination with decreased purchasing power
of the customers force companies to re-consider their product development strategies. Many examples support that products change their shape and become closer connected to intangibles.
Products, which have been newcomers not long ago (e.g. mobile phones, handheld computers etc.) are now becoming mature products and sells is not increasing as before. Quick model changes, technical updates or price reductions in order to improve the turnover are not sufficient solutions.
Due to the new situation, customer's demands and expectations change. An increasing number of people want to express their individuality. Even mass products have to be adaptable to individual demands regarding form, design and function. A long time of ergonomic development seeks its consequent pursuit on other sectors like cognitive ergonomic design in order to support the customer ability to understand technical gadgets in an easier way. Eventually many customers make their final decision unconscious and based on rather subjective factors. They purchase the product, which "feels" better, and are often unable to explain why. Taking this "feeling" into account already in the design process can give a substantial selling advantage. Kansei Engineering is a methodology for systematically exploring peoples "feeling" about a product and translation it into design parameters [2]. For this reason there are numerous mathematical models and software. With Kansei Engineering it is possible to define, improve and validate design of product and make direction for product to desired shape. It is necessary to take into account that application of Kansei Engineering demand a lot of time, resources an expert knowledge.

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THE EFFECT OF TWO MONTH TREATMENT OF DIVINE HEALTH PROGRAM ON BODY POSTURE FROM SAGITTAL POSE OF STUDENTS AGES BETWEEN 11 AND 14

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Abstract
The aim of this study was to determine if *Divine health program*, which is based on two breathing techniques, has an influence on body posture from sagittal position. It was tested on 16 students ages between 11 and 14, they were all healthy and without physical dissabilities. The secondary aim was to teach students how to breathe properly and educate them how important it is. The variable sample consisted of 10 numerical variables. The body posture indicator was measured by digital camera with high resolution, which was followed by photo tooling in sagittal left and sagittal right position in computer program "Posture Image Analyzer". According to the results, there are small and statistically insignificant value differences between the experimental and the control group. Therefore, conclusion is that Divine health program 8-week treatment (2x10 minutes during the extracurricular activities) did not significantly influenced the body posture from sagittal position of students ages between 11 and 14.

Key word: body posture, deep breathing,

kapalabathi (rapid breathing in every second)

Introduction

According to (Paušić J. K., 2012) posture or body posture is composition of all body joints positions in any moment, and it can also be explained like muscle balance. Posture is defined as alignment of body parts (Paušić J. K., 2012). Good posture is defined with balance of muscle and bone system that protects supportive body structures from injuries or progression of deformity, regardless of posture and dynamics of these structures. Muscles will work more efficiently in good posture, and optimal positions for pectoral and abdominal organs will be set up (Paušić J. , 2007). According to (Kosinac, 2008) features of good body posture are identified when following points are correspondingly leveled: the point between the eyes, chin, collarbone, sternum, pubic bone, and the center between the ankles, while biological spinal curves can be easily spotted from sagittal examination. By observing from coronal plane, shoulders, hips and knees must be on the same height, while the head must be upright, without deflection forward, or on the side. The result of this posture is efficiency of muscles, where gravity and active muscle strength are opposed and leveled. Bad posture is anomalous relation of different parts of body that causes increased strain of support structure that causes distortion of body balance. In most cases it is combination of few, exogenous and endogenous factors. Untensioned attitude and posture is created if we loosen up all muscles, and all body weight passively burdens the skeleton. That is why there is constant muscle function under the influence of men’s will in upright body posture (Kosinac, 2008). Hence, apart from muscle group that has postural function, there are other mechanisms that are responsible for regulation of body posture, and they are: postural reflex that works on the principle of feedback and makes continuous minor adjustments of body posture, sensory information coming from sensory receptors of the vestibular and visual system also have significant role. To maintain good posture, good functional upright posture, it is necessary to keep balance between group of muscles that are responsible for postural function, and that is possible to achieve with active and reflex regulation of extensor muscles of the lower limbs and back. According to (Kosinac, 2008) abdominal muscle tone is an important active regulator of body posture. Because of that breathing exercises have a significant function for correcting posture and tone abdominal muscles. if ventilation is faster and deeper (like in kapalabhati breathing technique), participation of expiratory muscles like M. obliquus externus, M. obliquus internus, M. transversus abdominis i M. rectus abdominis, is necessary. Therefore in preventive and corrective treatment of irregular body posture, breathing techniques have an important role.
Divine health program is a systematic and ancient system that was founded by Sri Siva Kumar

Swamiji Nasimath and Swami Urgaya (longterm qualified meditation and breathing techniques teachers, founders of international charity organization Divine Energy Park). This program is intended for all people (Urgaya, 2009). Divine health program consists of breathing techniques, psychophysical exercises and meditation, and the aim of the program is to enable every individual to set himself or herself free of deeply rooted stress and trauma in an easy and practical way and to achieve the harmony of all organic systems (Urgaya, 2009). Two breathing techniques are used in this study; deep breathing and a technique of forced exhale per second which is called kapalabhati (rapid breathing) or the Skull Shining Breath.

Breathing is a process of taking the air into and expelling it from the lungs as a consequence of three-dimensional changes in thoracic and abdominal cavities (Kaminoff, 2007).

According to (Kosinac, 2008), from physiological point of view, breathing has three vital phases: oxygen and carbon dioxide diffusion between the alveolus and blood, transmission of oxygen and carbon dioxide by blood and tissue liquids to the cells and back, and the tissue breathing. The first process is called external breathing or lung ventilation. The second process, gas transmission, is a blood circulation in the function of cardio-vascular system, and the third process is internal bleeding or tissue breathing (Kosinac, 2008). According to (Kosinac, 2008), breathing exercises present a process that can be identified as a degree of strength needed for the movement (of pectoral muscles and ribs), pectoral cavity and heart contents, motor (diaphragm) and lower abdomen.

According to (Urgaya, 2009), there are four kinds of breathing (low or abdomen breathing, middle or pectoral breathing,high or clavicle bone breathing and deep breathing). Deep breathing is the breathing that includes all three kinds of breathing; while inhaling abdomen extends first, then pectoral cavity, which is followed by the movement of pectoral and clavicle bones. Diaphragm moves down with the inhale and it moves up with the exhale, going back to the initial position. Kapalabhati is a technique of fast and forced expiration per second. Acharya Balkrishna and co-workers tested the effects of breathing techniques on various diagnoses, such as obesity, diabetes, high blood pressure, carcinoma, kidney function, arthritis, spondilits, heart diseases etc. It was tested on the sample of 10039 subjects. After seven days of intensive breathing the final testing showed the following: the tests on the function of lungs showed that 600 people improved the condition of respiratory system, 59 % of obese participants lost 2 kg, 34 % of them lost 10 kg, 43 % lost 2 to 5 kg and 6 % lost 5 to 10 kg. 457 of 743 participants with kidney diseases showed improvement, and 286 people showed improvement beyond expected values. According to Acharya Balkrishna (2007), kapalabhati cures heart and brain diseases, asthma, sinuses and other problems with breathing, constipation, it also regulates blood sugar, artery blockading. Doing kabalabhati exercises on regular basis cures constipation and diabetes without taking medicines (Balkrishna, 2007).

Methods

The samples of the study were 16 students, ages between 11 and 14, who attend Primary school Vrpolje-Perković. Experimental group consisted of 8 students, and the control group consisted of 8 students aswell. Variables which presented sagittal right and left posture review were: SRDL (deviation of the right lower leg line of the body from gravity line), SLDL (deviation of the left lower leg line of the body from gravity line), SRDU (deviation of the right upper leg line of the body from gravity line), SLDU (deviation of the left upper leg line of the body from gravity line), SRDT (deviation of trunk line of the right side of the body from gravity line), SLDT (deviation of trunk line of the left side of the body from gravity line), SRDN (deviation of the neckline right side of the body from gravity line), SLDN (deviation of the neckline left side of the body from gravity line), SRDP (deviation of pelvic right side line from gravity line), SLDP (deviation of pelvic left side line from gravity line). Preparation for measurement of body posture: mark the space for standing on the ground. Feet, apropos central points of imprint of heels, are 10cm apart, anterior parts of feet are faced outwards (angle of 20°). After that, we placed round yellow stickers diameter 1cm which represented referent points. The referent points are: top of the ear, acromion, spina illiaca anterior superior, middle of the hip, lateral epicondyle, lateral malleolus. After that we place the camera with stand and check the distance from stand position of student. The distance was 3m. The whole body of subject should be in camera frame. Stand and camera should be in horizontal position so that measure instruments won't affect the liability of results. Subject stands on marked line on the ground, placed lateral on left and right side (sagittal left and sagittal right analysis of body posture). Sagittal right stand is when student's right side and right arm in elbow flexion in 90° (right side lower arm is horizontal to the ground), while in left sagittal stand (the left lower arm is horizontal to the ground).

The initial measurement was done in February 2012, and the final measurement was done in April 2012. After the initial tests, certified Divine Health Program teacher taught the students of the experimental group two breathing techniques;

deep breathing technique and technique of fast breathing per second (kapalabhati). Experimental group practiced breathing techniques in the period of two months, 2 times 10 minutes a week, as an extracurricular activity.
Deep breathing technique is performed while sitting down in good posture with legs crossed, eyes closed, hands positioned on knees in the supination position. While breathing in the air, it expands stomach first, then the thoracic cavity and thoracic and clavicle bones. Diaphragm moves down while breathing in and it moves up while breathing out, going back to its initial position. The deep breathing technique is performed during the period of 5 minutes. The technique of fast exhaling per second (kapalabhati) is done while sitting down in good posture with legs crossed, eyes closed, and hands positioned on knees in the supination position. The inhale is natural (the stomach is in its initial position), and the exhale is forced, with the abdomen. While inhaling we contract all stomach's muscles and lower abdomen muscles (stomach must move towards the spine as far as it can). We do not hurry or strain ourselves. The rest of the body must be calm and relaxed (face, neck, arms), only the chest lightly moves up. We make one exhale per second (Urgaya, 2009). The exercise lasts 5 minutes. Note: if the chest moves down, we breathe with the upper part of lungs which in not the proper way. The proper way to do it is to breathe so that stomach moves towards the spine while exhaling.
Arithmetic mean, standard deviation (SD), the lowest and the highest results (min and max), α_3 (asymmetry coefficient), α_4 (kurtosis coefficient) were calculated by descriptive analysis. Distribution normalities were tested by Kolmogor-Smirnov procedure. Statistical importance of difference between the initial and the final values was tested by t-test for independent variables.
The results were processed by the program Statistica 8.0 (StatSoft, USA).

Results and discussion

Table 1. t- test results for independent samples between experimental (n_1=8) and control group (n_2=8) in all variables in initial and final measuring

	AS1I	AS2I	SD1I	SD2I	t	df	p	AS1F	AS2F	SD1F	SD2F	t	df	p
SLDL	-1,89	-1,79	2,99	3,39	-0,06	14	0,95	-2,25	-1,35	3,49	2,70	-0,58	14	0,57
SLDU	-4,96	-2,92	1,73	3,07	-1,64	14	0,12	-5,44	-5,26	3,10	2,86	-0,12	14	0,91
SLDT	0,84	1,38	2,67	2,05	-0,45	14	0,66	0,15	-1,28	2,12	2,61	1,20	14	0,25
SLDN	-8,70	-2,10	7,26	9,43	-1,57	14	0,14	-7,11	-4,07	3,81	4,59	-1,44	14	0,17
SLDP	28,38	17,61	7,37	21,60	1,33	14	0,20	-37,29	-29,96	6,65	21,35	-0,93	14	0,37
SRDL	4,75	2,90	3,34	4,41	0,95	14	0,36	2,71	2,04	3,60	3,73	0,37	14	0,72
SRDU	3,66	2,21	2,52	2,46	1,16	14	0,26	4,41	5,00	2,11	3,80	-0,38	14	0,71
SRDT	5,03	3,08	13,75	3,06	0,39	14	0,70	-2,61	-0,88	3,18	2,97	-1,13	14	0,28
SRDN	5,42	-3,25	5,98	6,40	2,80	14	0,01*	9,48	2,04	4,49	8,83	2,12	14	0,05
SRDP	-16,13	-24,47	20,72	6,09	1,09	14	0,29	26,10	34,29	24,07	7,97	-0,91	14	0,38

* statistically significant difference in $p<0,05$

Legend: AS1I (arithmetic mean of experimental group in initial measurement)
AS2I (arithmetic mean of control group in initial measurement), SD1I(standard deviation of experimental group in initial measurement), SD2I(standard deviation of control group in initial measurement), AS1F (arithmetic mean of experimental group in final measurement) ,AS2F (arithmetic mean of control group in final measurement), SD1F (standard deviation of experimental group in final measurement),SD2F (standard deviation of control group in final measurement).
From results in initial testing we can see how experimental and control group have statistically significant difference in one variable, and that is SRDN (deviation of the neckline right side of the body from gravity line), while in other variables the differences are not statistically significant. Results of final measurement show that there are inconsiderable differences in values of all variables between experimental and control group, but they are not statistically significant. The principal difference is seen in variables of SRDP

Table 2 t- test results for independent samples between experimental (n_1=8) and control group (n_2=8) in all variables in difference between initial and final measuring
(deviation of pelvic right side line from gravity line) and SLDP (deviation of pelvic left side line from gravity line).

	AS1	AS2	SD1	SD2	t	df	p
SLDL	-0,36	0,44	2,87	4,25	-0,44	14	0,67
SLDU	-0,48	-2,34	3,07	3,06	1,21	14	0,24
SLDT	-0,69	-2,65	3,47	2,73	1,26	14	0,23
SLDN	1,59	-1,98	4,88	7,41	1,14	14	0,28
SLDP	-65,66	-47,58	6,90	25,18	-1,96	14	0,07
SRDL	-2,04	-0,86	2,46	2,06	-1,04	14	0,32
SRDU	0,75	2,79	3,03	4,97	-0,99	14	0,34
SRDT	-7,64	-3,95	14,76	4,40	-0,68	14	0,51
SRDN	4,05	5,29	9,61	7,72	-0,28	14	0,78
SRDP	42,23	58,76	33,29	8,25	-1,36	14	0,19

The difference between variables in final and initial measuring, in experimental and control group refer to changes that occurred during 8 week treatment. According to results, there is not statistically significant difference between experimental and control group. Hence, the biggest differences in arithmetic means in results of final and initial measuring with control and experimental group is seen in variables of SRDP (deviation of pelvic right side line from gravity line) and SLDP (deviation of pelvic left side line from gravity line). This was expected due to degree of pelvic mobility and influence of deep breathing technique and kapalabhati (rapid breathing technique) on abdominal muscle tone and pelvic. Because, control group also marks the changes in the same variable, and does not have a statistically significant difference in variables of experimental and control group, it can be The effect of two breathing techniques from Divine Health program on posture or body posture was tested in this study, in sagittal left and right stand, on sample of 16 students ages between 11 and 14. They were all healthy without any visible physical disabilities or aberrations.

concluded that 8 weeks of performing Divine Health program (2x10 minutes a week, as an activity that is not included in the obligatory school subject) is not sufficient to produce statistically significant changes in sagittal left and right body posture of students ages between 11 and 14, what was expected due to short period of treatment duration.

Conclusion

week, as an activity that is not included in the obligatory school subject) is not sufficient to produce statistically significant changes in sagittal left and right body posture of students. Hence, this period was long enough to teach the children deep breathing technique and kapalabhati (rapid breathing technique) and to educate them about the importance of process of breathing on human organism and health.

By using T test on independent samples it is concluded that Divine Health Program does not have a statistically important difference between experimental and control group in all variables, and that a period of 8 weeks (2x10 minutes a

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AGRICULTURE SECTION

INFLUENCE OF THE CHEMICAL AND PHYSICAL PROPERTIES OF SOILS ON THE GERMINATION OF PEA (*Pisum sativum* L.)

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Abstract
The aim of this paper was to determine the influence of texture and pH value of the soil on germination and properties of germination for three sorts of garden pea (Mali Provansalac, Kelvedon, Čudo Amerike) on five different soil samples. Gathered data has been statistically analyzed with appropriate methods and results used for interpretation. In average, Mali Provansalac showed the highest value of germination energy, germination, length of the hypocotil and length of the roots. Cultivar Čudo Amerike showed in average the lowest germination energy and germination but the highest average sprouts mass. All cultivars showed the best germination energy on the soil with the lowest pH (6,033 and 4,27). Length of the hypocotil and roots showed independent of the pH of the soil although the highest values have been on the soils with lower pH values. Also all cultivars showed the best results of measured parameters in the heavy soils.

Keywords:
Pea (Pisum sativum L.), texture, pH reaction, sprout, germination

1. Introduction

Determination of germination has been accepted as major indicator of physiological quality of the seeds which has been used for calculation of sowing normative for getting desirable cultivar assembly in the field. According to research of Kendall at al. (1994) with different legumes there has been determined correlation between field and laboratory measures of germination with different pH values type of soils [1]. Soil is a very complex dynamic system with a lot of factors which influence on the plant and opposite [2]. The majority of vegetable cultivars have best results on the soil with neutral pH reaction with larger tolerance to acidity then to alkalinity [3]. In general, lighter soils allow better germination because there is no crust forming [3]. Because the texture defined as share of sand, powder and clay is not changeable through agrotechnics comparing with other physical properties of the soil the aim of this paper was to determine the influence of texture and pH on emergence and growth of three sorts of garden pea in early stage of developing.

2. Methods and Materials used for Research

During November 2010 research has been conducted with standard seeds of three cultivars of garden pea (Provansalac, Kelvedon, Čudo Amerike) of Semenarna Ljubljana seed producer in controlled conditions with average moisture of 80 % and temperature 20 °C. For germination examination 50 seeds of every cultivar have been sowed in three repetitions and in five types of the soil with different pH which is determined in water and in 1M KCl in laboratory of University of Applied Sciences in Slavonski Brod (probe SCHOTT 14). Texture of the soil samples has been determined with pipet method which is based partially on sieve and partially on sedimentation in still water. Type of the soil has been determined using Basic pedologic maps 1:50 000. Four days after sowing there has been first scan (germination energy) and seven days after sowing second scan has been done (standard germination). Measured parameters (length of sprouts, germination energy and standard germination) has been determined on all of the sprouts. For mass determining OHAUS scale has been use (± 0,01g). The SAS (SAS Institute Inc., 1999.) has been use for ANOVA statistical analyses.

3. Results and achievements

Production of the biomass of garden peas depends on a large number of genetic and agroecologycal factors (Štafa i Danjek, 1994., Popović i sur. 1997., Lecoeur i Sinclair 2001., Egli 2004., Poggio i sur., 2005.) [4] of which the soil plays very important role. One of the most important factors in crop quantity and quality of vegetable cultivars is pH reaction of the soil [5]. For some cultivars suitable pH reaction is different and for garden pea optimal pH value of the soil is between 5,3 - 7,4 according to Mengel i Kirkby (1987) [6]. With the aim to explore vigor and germination three sorts of green pea has been used on five soil samples of very different texture and pH reaction (Table 1).

Table 1. Physical and chemical properties of the soils used in research

Soil sample	Soils properties						
	Physical properties of the soils					Chemical properties of the soils	
	Clay (%)	Silt (%)	Fine sand (%)	Coarse sand (%)	Massive silt (%)	pH H2O	pH 1 M KCl
1	51,91 A	30,88 C	4,150 E	5,26 A	7,78 E	7,973 A	6,723 A
2	43,32 B	25,84 E	6,387 D	0,96 E	23,48 C	6,033 E	4,270 E
3	34,90 C	34,55 B	9,433 A	3,61 B	17,50 D	7,667 B	6,577 B
4	24,60 D	37,05 A	7,647 C	1,83 D	28,88 B	6,623 C	4,977 C
5	19,34 E	30,73 D	8,437 B	2,29 C	39,20A	6,530 D	4,740 D

P≤0,01 A,B,C,D,E

Soil samples has been determined by using the Basic pedological maps 1:50000 such as: Eugley (Sample 1), Terra rossa (Sample 2), Fluvisol (Sample 3), Pseudogley-luvisol (Sample 4), Podzol–pseudogley (Sample 5). Significant influence of the soil type for field emergence of field pea established Rapčan at al. during two year research [7]. Determining influence of texture of the soil on germination properties (Table 2) all cultivars showed the highest germination energy, standard germination, length of hypocotil, length of the roots and mass on the sample of the soil number 2 with high percentage of clay (43,32). According to Škorić (1986.) soils with heavy mechanic properties with increase of clay fraction and depending of minerals within makes unfavorable physical properties because of the density, viscosity, plasticity and bump forming [8]. Formation of the macro pores which are directly in correlation with clay content largely influences on the length of the root. In pseudogleys, infiltrations occurred preferentially in macro pores. The macro pore system allowed the unevenly distributed roots to take up water easily [9]. In this research different results occurred then those of prior mentioned authors.

Table 2. Average values of measured parameters in different soil types

Soil sample	Germination energy (%)	Standard germination (%)	Hypocotil length (cm)	Root length (cm)	Sprout mass (g)
1	64,00 B	84,88 B	6,21 AB	11,95 AB	0,79 B
2	83,77 A	92,22 A	6,89 A	12,44 A	0,89 A
3	46,22 D	68,00 D	5,52 C	9,86 D	0,80 B
4	58,00 BC	78,00 C	5,70 BC	11,29 BC	0,81 AB
5	55,33 C	71,33 D	5,36 C	10,54 CD	0,77 B

P≤0,01 A,B,C,D

In the Table 2 influence of the pH reaction of the soil on the germination and germination properties has been shown. In general the highest values for monitored parameters showed the soil with the lowest pH (6,03) Acording to Rašić at al. (2009) the highest germination energy and standard germination showed the seeds garden pea on the soil with pH value 5,85 [10]. Similar research conducted Bukvić at al. (2007) for germination of the seeds of field pea in dependency of pH value of the water solution in laboratory conditions. The prior mentioned authors [11] quotes that for the growing of the pea neutral and lightly acid soils are more suitable which is in positive correlation with our research where all three cultivars showed very significantly higher germination energy and standard germination in acid soil. During two year research with the pea on the area of the east Croatia Brkić at al. determined higher crop values on the soils with pH value 7,12 then 6,62 [12] which is partially in according to our results.

Table 3. Average values measured parameters for exploring cultivars on different soil samples

Cultivar	Germination energy(%)	Standard germination (%)	Hypocotil length (cm)	Root length (cm)	Sprout mass (g)
Mali provansalac	91,33 A	98,40 A	7,57 A	15,72 A	0,67 C
Kelvedon	59,86 B	75,20 B	4,91 B	9,06 B	0,78 B
Čudo Amerike	33,20 C	63,06 C	5,34 B	8,76 B	0,98 A

P≤0,01 A,B,C

Statistical analyzes of gathered data showed that germination and standard germination were under great influence (P≤ 0,01) of the cultivar (Table 3). Regarding that standard germination is depending of the cultivar and is between 82-95% [13] a little lower average germination can be addressed to the age of seeds [14]. In this research the difference between monitored cultivar has been very significant (P≤0,01) which is similar to the results of other researchers (Vieira i sur., 1999; Salinas i sur., 1998; Teklić i sur., 2004; Bukvić i sur., 2007.) [11]. Statistical analyzes of the influence of the soil characteristics on germination and germination properties showed that cultivars react differently on those characteristics (Table 4).

Table 4. Influence of the soil characteristics on measured parameters of each cultivar

Cultivar	Soil sample	Germination energy (%)	Standard germination (%)	Hypocotil length (cm)	Root length (cm)	Sprout mass (g)
Čudo Amerike	1	31 B	77 AB	4,48 B	7,9 B	0,96 n.s.
	2	78 A	93 A	5,88 B	12,44 A	1,11 n.s.
	3	15 B	38 D	7,7 A	6,73 B	0,1 n.s.
	4	20 B	59 BC	4,85 B	7,92 B	0,95 n.s.
	5	22 B	48 CD	4,22 CB	8,85 B	0,92 n.s.
Kelvedon	1	67 n.s.	82 a	5,88 n.s.	11,4 a	0,88 A
	2	75 n.s.	85 a	4,55 n.s.	9,34 b	0,78 AB
	3	50 n.s.	66 c	4,93 n.s.	9,07 b	0,76 AB
	4	58 n.s.	76 a,b	5,28 n.s.	8,11 b	0,85 A
	5	49 n.s.	67 b,c	3,92 n.s.	7,38 b	0,69 B
Mali Provansalac	1	95 a	96 b	7,33 n.s.	16,56 a	0,61 n.s.
	2	98 a	99 a	8,44 n.s.	15,56 b,c	0,78 n.s.
	3	73 b	100 a	6,8 n.s.	13,78 c	0,65 n.s.
	4	96 a	99 a	7,6 n.s.	17,85 a	0,64 n.s.
	5	95 a	99 a	7,69 n.s.	15,39 b,c	0,71 n.s.

P≤0,01 A,B,C,D
P≤0,05 a,b,c
n.s. - not significantly different

Figure 1. is showing average mass and length of the sprout (root and hypocotil) on investigated soils. Seeds of the cultivar Mali Provansalac developed long sprouts with low mass on all soils and Čudo Amerike on the sample with pH 7,63 and 34,9 % of clay content. Cultivar Kelvedon showed similar mass and length of the sprouts on all soil samples.

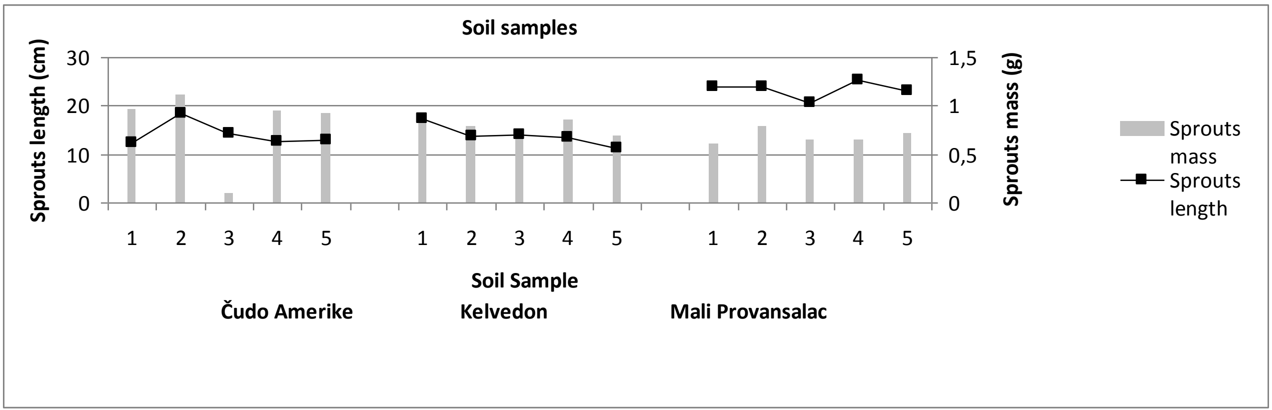

Figure 1. Average mass of the sprouts (g/sprout) and lenght (cm) on the soils with differnt physical and chemical characteristics

4.Conclusion

- cultivar Mali Provansalac showed in average the highest germination energy, germination, length of hypocotil and root
- on the soil with the lowest pH value all cultivars showed the best germination and germination energy
- the length of hypocotil and root the influence of pH is not significant in neither cultivar although the highest values has occurred on the lower pH value
- average mass of sprouts of all cultivars is statistically significant on the lower pH value of the soil (6,03 and 6,62) but on other values of pH there was no difference
- on the soil sample with 43,32 % of clay, 25,84 % of silt, 6,39 % of fine sand, 0,96 % coarse sand and 23,48 % massive silt the best results have been determined for all of the observed parameters
- measured parameters had high values on the soil with high share of clay 51,91 %

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INFLUENCE OF PRODUCTION CONDITIONS ON GROWTH AND DEVELOPMENT OF KOHLRABI (*Brassica oleracea var. gongylodes* L.)

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Abstract
Yield and quality of kohlrabi depends of genotype and agroecological conditions during growth and the best conditions are sunny, cold and wet areas. Germination of kohlrabi depends on environmental factors as well as vegetation growth which means that oxygen, water, optimal temperature must be presence and there must be abscense of inhibition factors. Regarding thessee facts during May 2011 experiment with two production conditions which vary in temperature and lightening has been carried on. Research has been conducted in greenhouse and hotbed of the University of Applied Sciences in Slavonski Brod using Vienna white and Vienna blue kohlrabi specieses, with 100 seeds sowed in plastic containers 3x3 cm in two repetitions in both production conditions. During the experiment germination showed significant correlation connection (r=0,998** and r=0,999**). Germination speed of Vienna white and Vienna blue also showed very strong positive correlation (r=0,992** and r=0,989**). Statistical data treatment showed no significant difference according germination energy and seed germination (P≤0,01) depending on production conditions and cultivar. However other average values (length of roots, length of above ground part, length of transplant, mass of transplant) have been very significantly under influence of production conditions and mass of the transplants as well as length of the above ground was under influence of cultivar. In the average Vienna blue showed significantly higher values of above ground length and average mass of the transplant. Regarding our results we can conclude that in greenhouse quality of transplants is significantly higher than in hotbed which indicates on the importance of choosing the adequate production conditions for growth and development of kohlrabi.

Keywords:
Greenhouse, Hotbed, Kohlrabi

1. Introduction

Cabbage vegetables (Brassicaceae), in which kohlrabi is assort, are vegetables adapted it different climate and soil conditions but which prefer lower temperatures. Generally, in vegetable production among most important conditions are light, heat, moisture and pH reaction of the substrate. Kohlrabi, like cabbage and other cabbage vegetables climate and soil needs for emergence, germination and development are similar which means that they succeed the best in coldly and moisture climate. Although the high light transaction is necessary for plant growth [1] the density of the shade must be adjusted according to species [2]. Needs for light of kohlrabi are moderate, it likes sunny and light shade places but it will not tolerate full shade. As like the other cabbage vegetables kohlrabi is usually cultivated out of transplants. For early spring production the transplants were produced in protected areas on the temperatures higher than 14 °C. Nowadays many of vegetable cultivars have been produced in greenhouses because the production conditions are under control. In field conditions kohlrabi is cultivate from transplants out of greenhouses or it can be completely produced in greenhouses. Vegetables can be cultivated in different conditions, traditional vegetable garden, greenhouses, pots, on windows and in the field so the aim of this research is to determine influence of different production conditions on growth and development of two cultivars of kohlrabi (Vienna white and Vienna blue).

2. Methods and Materials used for Research

Certified seeds of two cultivars of kohlrabi (Vienna white and Vienna blue) from seed producer Semenarna Ljubljana (Kolerabica Dunajska bela i Kolerabica Dunajska modra) have been sowed 10 of May 2011 in two different production areas, greenhouse and hotbed at the University of Applied Sciences in Slavonski Brod with different temperatures and different light conditions. Hundred seeds of each sort have been sowed in Potgrond P substrate in plastic containers (100 seeding posts 3x3 cm) with two repetitions. During research maximal and minimal temperature has been monitored daily in greenhouse and in hotbed as well as number of appeared seedlings. At the and quality of all transplants have been determined by measuring the length of the root, length of above ground part, length of complete transplant, mass of complete transplant and from measured data average values have been calculated and statistically analysed by SAS programme package (SAS Institute Inc., 1999.).

3. Results and achievements

Optimal temperatures are those when plants have the biggest growth and development and they are different for every sort and phase of growth and development. During this experiment minimal and maximal temperature were measured in greenhouse and in hotbed (Figure 1.) and temperature in greenhouse showed larger oscillations then those in hotbed.

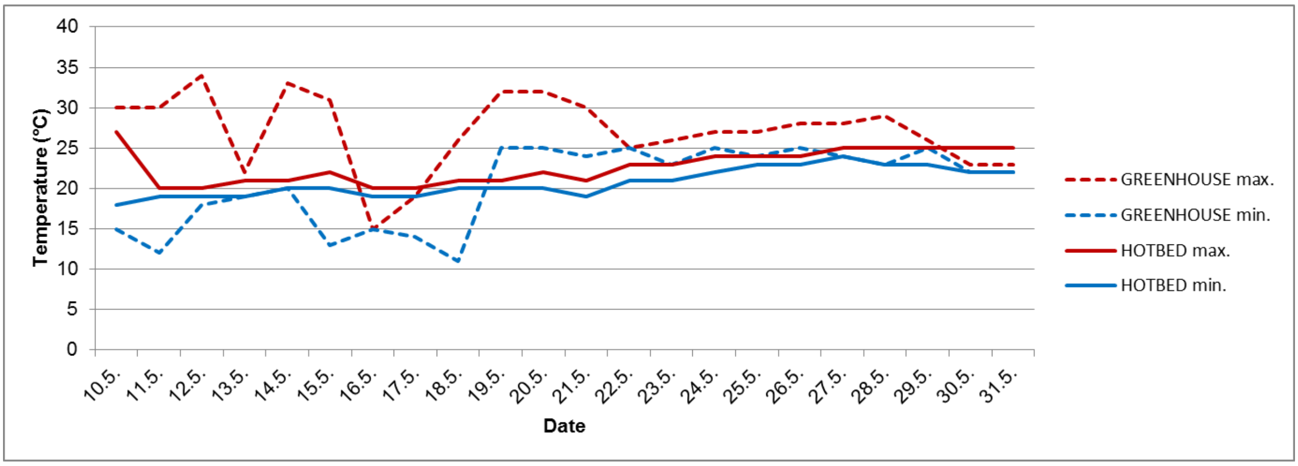

Figure 1. Minimal and maximal temperatures during growth and development of kohlrabi

According to Lešić at al. (2004) conditions for emergence and germination are same for all cabbage vegetables which means that optimal temperature is 20 °C while the optimal temperature for growth and development is 14 °C to 20 °C by day and 8 to 12 °C by night [3]. Parađiković (2009.) quotes that cabbage vegetables have lesser needs for heat and therefore they start germination at 2 °C to 3 °C while the optimal temperature for germination is 18 °C to 25 °C and for growth and development of vegetative organs is 13 °C to 19 °C [1]. Average maximal temperature during research was 27 °C in greenhouse and 23 °C in hotbed and according to statements of fore mentioned authors leads to conclusion that emergence and germination were took place in the conditions of elevated temperatures. In this research standard seed from seed producer Semenarna Ljubljana has been used, untreated with declared intergrowth of 82 % for Vienna blue and with recommended use by 15th of October 2013. Vienna white has declared intergrowth of 75 % and recommended use by 15th of October 2012. In green house production of transplants, number of emergence plants of both cultivars have been measured in equal intervals. Both cultivars reacted similarly to environmental conditions and showed significant correlation in emergence r=0,998** (Figure 2.).

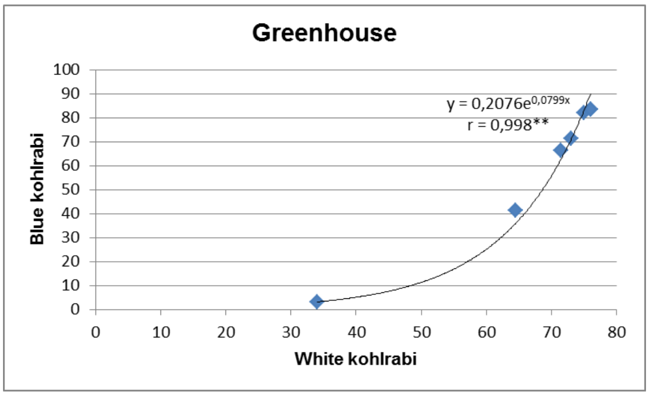

Figure 2. Correlation of intergrowth oh kohlrabi in greenhouse

Number of emergence plants of white and blue kohlrabi in hotbed also showed strong positive correlation (r=0,999**). According to intergrowth depending of growing conditions it can be concluded that there was no significant difference between greenhouse and hotbed conditions and number of appeared plants of Vienna white and Vienna blue kohlrabi in greenhouse and hotbed showed significant correlation (r=0,992**, r=0,989** respectively) Figure 3. Environmental factors (heath, moisture, light etc.) are often in interaction in way that they regulate intergrowth of seed [4] which depends on the same environmental conditions as vegetative growth which means that oxygen and water has to be present, temperature has to be favorable and there has to be no inhibition factors.

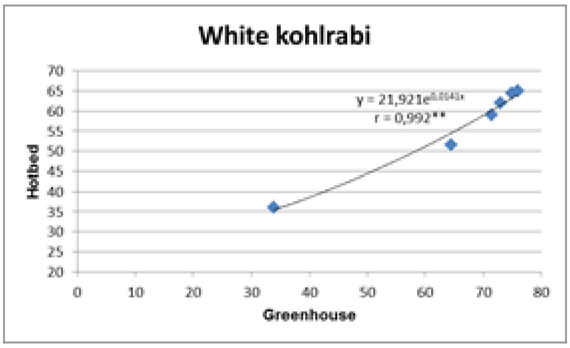

Figure 3. Correlation of emergence of Vienna white kohlrabi in greenhouse and hotbed

With the aim to test seed for production of transplants energy of germination and germination was determined (Table 1.) and results showed no significant difference between production conditions as well as sort influence on for mentioned parameters even though the seeds of white kohlrabi was 12 months older. Other measurements of properties of the transplants showed in average under very significant influence of production conditions. Length of the root of transplants was under very significant influence of the production area (F=196,413**) which showed average 6,06 cm longer roots of those from greenhouse then those from hotbed.

Table 1. Average values of observed properties of seeds and transplants of kohlrabi depending of treatments

Property	Growing conditions		Cultivar	
	Greenhouse	Hotbed	White kohlrabi	Blue kohlrabi
Germination energy (%)	53 A	57 A	58 A	52 A
Germination (%)	79,75 A	77 A	70,5 A	86,3 A
Root length (cm)	9,45 A	3,39 B	7,06 A	5,78 A
Above-ground length (cm)	10,89 A	7,04 B	7,82 B	10,1 A
Transplant length (cm)	20,34 A	10,43 B	14,89 A	15,88 A
Transplant mass (g)	1,06 A	0,12 B	0,55 B	0,63 A

P≤0,01 A,B

Average length of above ground part of the transplants was 3,85cm longer in those from greenhouse then in those from hotbed (F=81,199**) but this parameter was under significant influence of sort (F=28,304*) and transplants of Vienna blue were average 2,28 longer above ground part of transplant. Very significant influence of production area (F=395,972**), greenhouse, has been measured on length of transplant. Average mass of fresh transplant was under very significant influence of the cultivar (F=74,976**) and production conditions (F=11777,817**). Statistically analysed data of influence of the production conditions on the cultivar (Table 2.) showed no significant influence on germination energy and germination both cultivars as well as on average length of above ground part of the transplant regarding Vienna white kohlrabi. Both cultivars have been under Too dense shade may result in etiolation (thin weak seedlings) of light demanding species [5,6].

significant influence of the greenhouse production conditions (F=311,697**), under which white kohlrabi developed 10,39 cm longer and blue kohlrabi 9,44 cm longer transplants.
Also both cultivars developed significantly higher mass of the transplants in greenhouse then in the hotbed. Blue kohlrabi showed significantly longer above ground part of the plant (F=68,821**) and both cultivars showed longer roots (F=745,575**) when produced in greenhouse.Basic difference among observed production conditions is one considering the amount of light. In greenhouse transplants has grown and developed on direct sunlight which regarding the date of sowing (10.5.2011.) was intensive, day after day and approximately 17 hours a day. In hotbed plants has been grown 40% of the time in partial shade without direct sunlight. It is well known that plants on light and in the dark differs significantly.

Table 2. Influence of the production conditions on observed properties of seeds and transplants of the Vienna white and blue kohlrabi

Property	White kohlrabi		Blue kohlrabi	
	Greenhouse	Hotbed	Greenhouse	Hotbed
Germination energy (%)	64,5 A	51,5 A	41,5 A	62,5 A
Germination (%)	76 A	65 A	83,5 A	89 A
Root length (cm)	10,45 A	3,66 B	8,44 A	3,11 B
Above-ground length (cm)	9,62 A	6,02 A	12,16 A	8,04 B
Transplant length (cm)	20,08 A	9,69 B	20,60 A	11,16 B
Transplant mass (g)	1,01 A	0,08 B	1,10 A	0,15 B

P≤0,01 A,B

4. Conclusion

Intensity of emergence of both cultivars independent of producing conditions showed very significant positive correlation. Vienna white and Vienna blue cultivars of kohlrabi show no difference in germination energy and germination in different producing conditions. Higher values of root length, length of above ground part of the transplant, whole transplant have been measured in green house. In green house Vienna blue developed higher mass, longer above ground part of the transplant, root length and length of the whole transplant.Vienna white developed in green house significantly longer transplant with higher mass and longer root then in hotbed.According to gathered data we can conclude that the choice of appropriate producing condition which fulfill needs of the cultivar in vital for getting the quality transplants.

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SOCIO-ECONOMIC CHARACTERISTICS OF FAMILY FARMS IN BROD-POSAVINA COUNTY

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Abstract
Family farms are the organizational units in agriculture and they are based on private ownership of land, as well as on other means of production.
The foundations of these units are families or households, which are the basic social communities in which a succession of generations and realization of economic activity necessary for the survival of those communities take place.
This paper presents the results of a study focusing on socio-economic characteristics of family farms in the municipalities Klakar, Sibinj, and Oriovac located on the territory of the Brod-Posavina County. The study was conducted on 108 family farms during the months of March and April of 2011. Particular attention was paid to the socio-demographic characteristics of family farms, such as the age, gender, education, employment, and professional status of the household members, as well as to the basic characteristics of the farm, such as land and equipment used in the production.
Based on the data collected in this study the possibility of family succession, as well as the economic survival of family owned farms, has been estimated.

Keywords:
Family farm, successor, Brod-Posavina County

1. Introduction

Family farms reproduce as a production unit, an economic unit and a socio-demographic unit. Economic reproduction refers to the repetition of the cycle of production, exchange, distribution and consumption, and it is the main criterion for determining future levels of production, as well as the direction of the development of the farm. Economic reproduction significantly depends on the resources available for agricultural production (land, equipment, available funds and human resources) and on the management and organization of the family. Socio-demographic reproduction refers to the reproduction of the household as a community and of agricultural labor force. There is no future for economic development without socio-demographic reproduction; therefore it is important whether the farm would be divided between successors or it would be inherited by only one successor and whether the successor(s) would be interested in continuing the agricultural production, which depends on various external and internal factors. Another important set of factors are the age, gender and profession of the successor(s) [1].
Many authors have conducted studies on the social reproduction of peasant farms. In the 1960s Robert Kurbel conducted a study on the socio-economic changes in the villages of eastern Slavonia. He defines the term “farm succession” as “the possibility of continuing the production on a farm, an economic unit controlled by one successor”. From the standpoint of social reproduction, Josip Defilippis (1993) distinguishes three groups of farms: those whose successors stay on the farm, those which educate children who intend to leave the farm, and those with no successors [2]. According to Vlado Puljiz (1974), social reproduction is “a form of creation of farms as socio-economic units after the retirement of the current head of the farm” [3]. Decisions regarding the reproduction of socio-demographic units were the subject of a study conducted by Ruža First-Dilić on members of rural households above 18 years of age. The author claims that the changes in the structure of family authority are a result of other changes in rural communities [4]. A study by Brkić and Žutinić (1993) conducted in the Zagreb subregion yielded the following results about the attitudes of farm heads regarding the staying of a successor on the farm: there is a significant connection between social reproduction and the type of farm, as well as a family’s size and type [5]. Survival of many family farms depends on the success of the intergenerational transfer [6], and the entry of the “next generation” into agriculture determines the structure of the country’s economy and the total number of farmers and farm families [7]. Wiliams and Farrington underline that “the successional process has become increasingly complex as the patterns of succession and inheritance continue to adapt to the changing economic and social conditions” [8].

2. Methodology

The sample was taken using the random selection technique, while the basic method of collecting data was a survey. The survey contained questions pertaining to attitudes and opinions of the owners regarding the succession of family farms, questions addressed to potential successors about their interest and willingness to take over the farms in the near future, their motives for engaging in agricultural production, their attitudes about the future direction and scope of production, and questions about the conditions that need to be fulfilled for the development of the farms. Each farm manager completed a written questionnaire and thus provided socio-demographic data about the household members, the basic production characteristics of the farm, and answers to questions regarding the succession of the farm. The study was conducted in three municipalities (Sibinj, Oriovac and Klakar) of the Brod-Posavina County, and the sample included 108 family farms.

3. Results and discussion

Household characteristics

The settlements in the rural area of Brod-Posavina County are clustered, and there are many villages. The households that participated in the study were owned by elementary, that is, nuclear families (parents and their children), with an average of 4.14 family members, which is more than the 2001 average family size in the Brod-Posavina County of 3.22 family members [9]. The difference can be explained by the following facts: farmers tend to have more children, the fertility rate among the women in the villages is higher, and different generations of families more often live together in villages. The size of families on family farms is important from the standpoint of socio-demographic reproduction of family farms because a larger number of members can (but not necessarily) guarantee a “more successful” reproduction. That means that a higher number of potential successors raises the probability of one of them staying on the farm. On the other hand, if the successors are not interested in taking over the farm and if the farm head has not chosen a successor, the farm could be atomized when it is divided among successors who do not engage in agricultural production, and that way it would be marginalized as a production and economic unit.

Production and economic characteristics of family farms

The average size of agricultural land per farm included in the study was 5.1 ha (12.6 acres). Arable land covers the largest share of agricultural land – 84.2%.The percentage of the land covered in meadows and pastures is 9.5%, in orchards 5.8%, and less than one percent contains vineyards.

Regarding land under crops, grain production is the most important - corn covers 48.05% of the land, wheat is next with 23.93%, then barley and oats with 16.1% - and other crops (soybean, sunflower...) cover 11.87% of the land.

There were a total of 296 head of cattle on 31 farms, which is far below the standard necessary for serious cattle breeding, and there were 1804 pigs on 84 farms. 19.35% of farms focused on cattle breeding owned more than 10 cows of quality breeds for milk production, and 11.9% of farms focused on pig breeding owned more than 30 pigs. However, 18.5% of farms did not own either cattle or pigs.

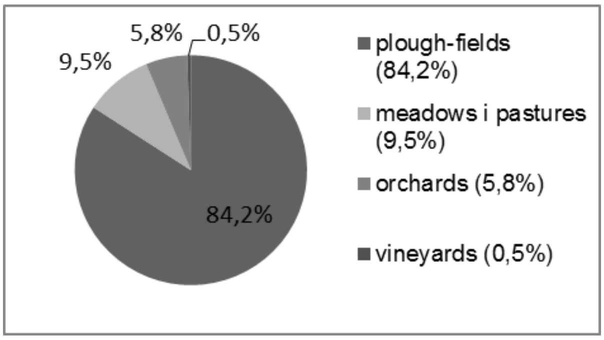

Figure 1. Structure of agricultural land

Most of the farms included in the study engage in livestock breeding only for their own use and they produce pigs and poultry.

The machines that family farms are equipped with influence the production characteristics of those farms. There were 120 tractors on the farms included in the study – labor-intensive farms owned two or three tractors and smaller farms most often owned one. As for tractor applications, the farms most often owned single-axle carts, multiple-furrow ploughs, disc harrows, sprayers, cultivators, animal manure spreaders, and processing equipment, which was used on dairy farms.

Socio-demographic reproduction of family farms in the Brod-Posavina County

In Croatian works on agriculture, possible successors are defined as “all males who live on a farm or are temporarily absent (e.g. for education, seasonal work, etc.), and are at least ten years younger than the head of the farm” [10]. According to the authors, potential successors include minor children (under 14 years of age) and active farmers and non-farmers (including dependents) aged 15 and over. In studies on the social reproduction of family farms, many authors start from subjective assumptions and the resources that the farm has. However, it has been proven that the professional position of a potential successor is the most important and only objective indicator of whether a farm would reproduce and in which form. A survey was conducted among farm heads regarding their intentions of keeping a successor on the farm. At 49.07% of the farms, the farm head chose one successor for the farm, 18.52% of the farms have more than one successor, while at 31.48% of the farms there are no successors or the farm head has not decided to whom he will leave the farm.

Socio-professional characteristics of potential successors

Figure 2 shows that 23.53% of the potential successors in the study were 36 years old or older, 30.59% were between 25 and 35 years of age, and 45.88% were younger than 25 years. It is expected that the successors older than 35 years will be the ones most interested in inheriting the farm soon.

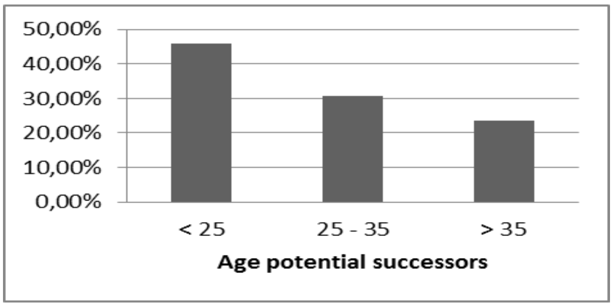

Figure 2. Age of potential successors

Studies of the potential reproduction of family farms show that the real candidates for taking over the farm are determined with regard to objective factors, the most important one being the professional position (education, employment) of the potential successor. Most potential successors (66.32%) finished secondary school, the largest part of which (77.9%) graduated from a vocational school (economic, commercial and medical), and 18.1% either graduated from a secondary school of agriculture or are still attending that school.

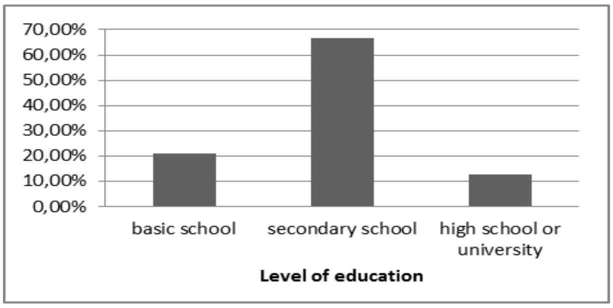

Figure 3. The educational structure of potential successors

The professional position of a successor (employment on the farm or somewhere else) as an objective criterion significantly determines the socio-demographic reproduction of a family farm and the continuity of production on the farm. For example, the reproduction of family farms on which the successor is a farmer is almost certain, whereas the possibility of the reproduction of family farms whose successor has a non-agricultural occupation is much lower. The same can be said for adult successors. Potential successors who are minors are still in school and it is very difficult to determine whether they will stay on the farm or not. This study found that potential successors have the following professional positions: 59 of them are employed and 33 are unemployed, that is, dependent (pupils, students and the unemployed).

Table 1. The profession of potential successors

Profession	Share (%)
Workers and civil servants, executives in the state / private enterprise	45,65
Entrepreneurs / private owners (own company)	5,43
Farmers on the family farm	13,04
Dependent members (students and unemployed)	35,87
Total (N = 92)	100,0

Given that most potential successors are employed outside the farm (Table 1) it is important to determine whether they participate, and how, in the affairs of the family farm. It is realistic to assume that those successors who participate more in the activities on the farm will have stronger intentions and motives to take over the farm and, at least, maintain the existing levels of production
However, among successors over 36 years of age there are twice as many of those who would like to maintain the same production levels as there are those who would like to increase them. The attitude of a potential successor regarding future production levels, that is, the successor's willingness to increase, maintain, or decrease the existing production levels of a farm, is significantly influenced by his formal education and employment. Younger, better educated and more adventurous (risk prone) successors who work on the farm want to increase the agricultural production levels of the farm after the succession, which is extremely favorable for socio-demographic reproduction. However, most dependent members and successors who work outside the farm plan on maintaining the existing production levels. Also, as the income of a farm from agriculture grows, the number of potential successors interested in increasing the agricultural production levels of the farm when they succeed also grows.
Future production levels depend on the employment position of potential successors. The successors who work in companies account for the largest percentage (29.87%) of successors who will maintain the current production levels, while those who work at the family farm account for the largest percentage (6.49%) of those who will increase the current production levels. Regarding the successors who are employed in a craft, 2.6% of them will increase or maintain the current production levels, and 1.3% will decrease them.

Students, the unemployed and dependent family members account for the largest percentage (12.99%) of successors who will maintain the same production levels.

4. Conclusion

Viability of family farms depends primarily on the well-timed retirement of the farm head from the position of owner and manager of the farm and the transfer of those functions onto a successor. In Croatia, it usually occurs when farm heads are unable to perform their duties due to age, illnesses, or death. This study showed that 39.81% of the current farm heads are older than sixty years, and 38.89% are retirees who still have not left their farm to a successor, which places the successors in an unfavorable position because of a lack of independence in the management of farms. Due to that, the “successor’s effect” - which is reflected in the change of the scope and direction of current production, new investments and other actions - does not exist on these farms.
Out of 108 family farms included in the sample, 78.7% have a potential successor and their reproduction is possible. However, on 21.3% of farms, which have no successors, the probability for socio-demographic reproduction is very low, and 8.33% of farms face the problem of “premature succession” because their potential successors are minors and the farm heads are younger adults. Out of the farm heads who have chosen a successor, 72.7% chose their sons, while only a small portion (27.3%) chose their daughters because they have no male successors. On 23.26% of farms, there are more potential successors, and 11.1% of farm heads still have not decided who will succeed them.
The study of the professional positions of potential successors as a factor in choosing the successor has shown that only 12.64% of potential successors are farmers, whereas 45.26% of them are employed outside the farm. On 25% of farms the potential successors are dependents, and on 29.63% they are still unknown (minors and farms without successors). Less than half of the successors are ready to take over the farm and engage in agricultural production as the sole (successors-farmers) or an additional source of income, while 59.26% of the successors do not intend to take over the farm.
The attitudes of farm heads regarding the staying of a successor on the farm and the professional positions of the successors indicate that 1 in 9 (11%) farms will reproduce as an agricultural unit. The results of the study show that it can be expected that the successors of those farms will invest in new resources and increase the production levels, which will enable long-term agricultural production and provide a stable professional status for the successors. However, the majority of farms will reproduce either as mixed or non-agricultural farms – they will be succeeded by non-farmers for whom agriculture is an additional occupation or a hobby. Future agricultural activities on those farms, as well as the scope and type of production, are uncertain, and the future status of the farms will be closely connected to the professional status of the successors. Finally, it is probable that 13.89% of the farms will cease their agricultural production due to the disinterest of the successors.

5. Acknowledgement

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STUDY OF ECOLOGICAL FLUID PROPERTIES UNDER OPERATIONAL CONDITIONS OF TRACTORS

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Abstract
The paper deals with testing of ecological gear hydraulic fluid which was applied in the tractor Zetor Forterra. The operational test on the basis of results obtained from accelerated laboratory tests of ecological fluid was carried. The fluid is produced by MOL Group. During the operational test the flow characteristics of hydrostatic pump type UD 25 at the nominal parameters were measured. The test lasted for 900 Eh, during which in a given time we are collected from selected sampling point a representative samples and evaluated their qualitative properties.
The valuation of content of contamination parameters we used an optical device CS 1000, which evaluates the number and size of particles in an ecological fluid and the ICP spectrometry. We also evaluated the physical-chemical properties such as total acid number and kinematic viscosity.
After 900 Eh the fluid parameters showed the limits of contamination which it can endanger the continued running of machinery. In conclusion, therefore, the authors deal with the life extension of the ecological fluid by proposed filtration system in the laboratory at the Department of Transport and Handling, Faculty of Engineering, Slovak University of Agriculture in Nitra.

Keywords:
Ecological fluid, tractor, qualitative properties, contamination, filtration.

1. Introduction

Due to advantages in renewability and environmental acceptability, bio-sourced and biodegradable hydraulic fluids are increasingly used in fluid power applications [11]. In this time, the difference between of conventionally produced fluid and ecological fluid two or three times of the price. Therefore is necessary to look for new solutions how to extend the technical life, which could have the effect on their increase use. Consumption of ecological fluids in EU is 0.12 Mt per year from total world production of 35 Mt per year [10]. Almost 50 % of all the sold oils in the world finish at present times as forfeits during the operation in nature [5].
In working device the fluid transfers the energy and also carries the information about process in it. Into the fluid during the device operation entrance metal particles through which is possible to evaluate a wear process and predict the next operation of the device. Particle contamination in hydraulic fluid accelerates wear of system components [1]. Therefore is very important to pay attention to purity of hydraulic fluid which is used.
The fluid should be replaced if the value exceeds the limits, which are specified by manufacturer. The most common hydraulic fluid contaminants are water and air, along with particles of metal, rubber or dirt [9]. If the fluid is contaminated and has a good physical-chemical properties (total acid number, kinematic viscosity, water content) have to be replaced. This means shortening the operational life. It is an uneconomical solution especially for expensive ecological fluids. Solution can prevent by the right choice of filtration [13, 7].
Flow characteristics of UD 25 hydrostatic pump on the experimental device at the Department of Transport and Handling, Faculty of Engineering were measured. Hydrostatic pump type UD 25 was mounted on the Zetor Forterra 114 41 tractor.

2. Materials a method

Properties of ecological fluid type HERP (VDMA 24568) were studied under operational conditions in Zetor Forterra 114 41 tractor. The operational test on the basis of results obtained from accelerated laboratory tests of ecological fluid was carried. The ecological fluid is a newly developed ecological fluid, which is made with synthetic base fluid based on poly-alpha-olefins. We choose this fluid, because it has high chemical stability and miscibility with mineral fluids, which are currently used in tractors in Slovakia. This fluid is a new type of ecological fluid with name MOL Farm UTTO Synt, made in MOL Group, Hungary.
This fluid belongs to the group of universal transmission hydraulic fluid designed for tractors. The specifications of fluid are: kinematic viscosity at 40 °C = 58. 14 $mm^2 . s^{-1}$; kinematic viscosity at 100 °C = 10. 22 $mm^2 . s^{-1}$; viscosity index = 165; pour point = (-42 °C).
During operation of tractor the following physical–chemical properties of ecological fluid: kinematic viscosity, total acid number, water content, contamination of fluid particles by cleanliness code (ISO 4406), contamination of fluid particles by ICP spectrometry, fluid mixtures contamination by infrared spectroscopy were observed.

During sampling, we have to ensure a procedure by which it was necessary to observe all of sample case principles and sampling equipment. Others important factors during obtaining of representative samples are the right choose of delivery points, mixing and heating the fluid at operating temperature.
During operation of tractor, we monitored the fluid effect on wear of tractor hydraulic pump. In case of Zetor Forterra tractor the hydraulic pump is in operation immediately after the engine starting. The quality of ecological fluid influences on wear always whenever the tractor is working. Hydraulic pump is a part of the hydraulic system which is susceptible to wear and its possible for the simple dismounting easily evaluate the technical state on the basis of flow efficiency.

3. Flow rate characteristic of hydrostatic pump

After completing of 450 and 900 Eh was unmounted hydrostatic pump type UD 25 from the tractor. It was placed consecutive in an experimental device for measuring the rate characteristics. The characteristics were measured at nominal rotations of 1500 rpm. In the picture 1 are depicted the flow characteristics of the UD 25 hydrostatic pump.

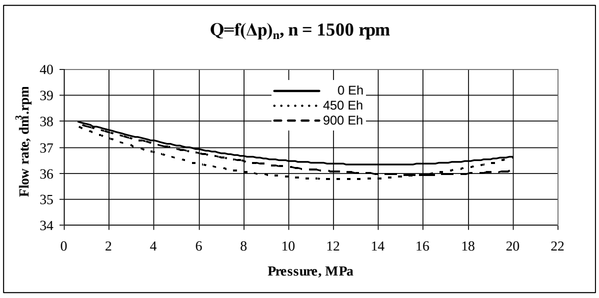

Fig. 1 Flow rate characteristic of hydrostatic pump at n = 1500 rpm

4. The calculation of flow efficiency decrease

The standard STN 11 9287 determines the way of the test evaluation. The fluid must by evaluate by flow efficiency decrease of the hydrostatic pump s follows [12]:

$$\Delta\eta_{pr} = \frac{\eta_{pr0} - \eta_{pr900}}{\eta_{pr0}}.100 \qquad (1)$$

where:
$\Delta\eta_{pr}$ – flow efficiency decrease (%)
η_{pr0} – flow efficiency at 0 engine hours (start of the test)
η_{pr900} – flow efficiency after 900 engine hours (end of the test)

Then, the flow efficiency is expressed by the equation:

$$\eta_{pr} = \frac{Q}{V_G \cdot n}.100 \qquad (2)$$

where:
Q – flow of hydrostatic pump (dm^3.rpm)
V_G – geometrical volume of hydrostatic pump (dm^3)
n – nominal rotation speed of hydrostatic pump (l.rpm)

Rotation speed of 1500 rpm and pressure of 20 MPa at 0 Eh result in the flow rate of 36.17 dm^3.rpm and of 36.33 dm^3.rpm at 900 Eh. The flow rate decrease is 1.197%. Tkáč et al. [12], using the hydrostatic pump UD 25 with biodegradable oil type ERTTO, obtained a decrease of flow rate of 7.3 % after 10^6 cycles of pressure loading (STN 11 9287). Drabant et al. [3] obtained a decrease of flow rate of 3.6 % at revolution of 1500 rpm and pressure of 20 MPa after 300 Eh.

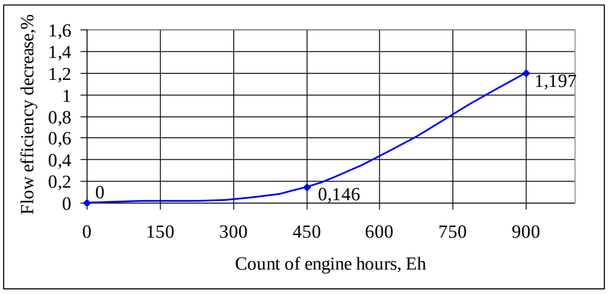

Fig. 2 The flow efficiency decrease of UD 25 hydrostatic pump at n = 1500 rpm

5. Origin analysis of ecological fluid contamination

Evaluation of ecological fluid by IR spectroscopy is in figure 3. In areas around 1650 cm^{-1} and 1600 cm^{-1} are parts of IR spectra at which we can see the change of identity of used fluid. From 450 EH we can see the resizing of peaks in observed areas which can be to attribute to mixing of ecological fluid and other fluid. This mixing and the resulting contamination are caused by connection of attachments from outer hydraulic circuit of tractor. Based on the size of the peak in area 1600 cm^{-1}, we can assume that the tested ecological fluid was mixed with mineral fluid used in majority of agricultural machinery in Slovakia. The type of contamination is likely that this are resin, which are produced during the degradation processes – fluid aging. It is characteristic of the degradation of mineral fluid which is mixed with the used fluid during test.

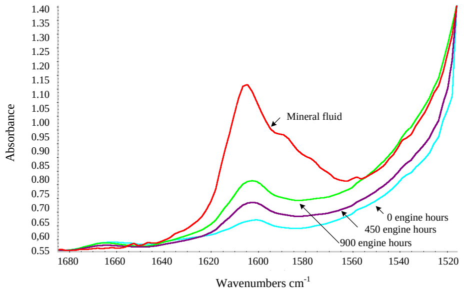

Figure 3 Evaluation of contamination of ecological fluid by FT-IR spectroscopy

6. Physical-chemical properties of ecological fluid

Manufacturer considers the fluid as eligible for continued operation if the measured values of kinematic viscosity are within tolerances ± 10 % in view of new fluid. The values of kinematic viscosity measured at 40 °C (table 3) are in required tolerance during test. Whereupon that the fluid is possible in term of kinematic viscosity used without exchange.

Also total acid number (table 3) is important evaluation parameter for fluid, because an increase of acids is characterized by aging, degradation of fluid. The measured values didn't exceed the limit value and the ecological fluid can be used without exchange.

Water in the hydraulic system acts as degradation catalyst and can impair some additives, increase the acid number and creating conditions which are suitable for corrosion. During the measurements of water content, we don't found water in fluid and a fluid meets for next operation (table 1).

Table 1 Values of physical-chemical properties of ecological fluid

Parameter	Unit	Count of engine hours			
		0 EH	150 EH	450 EH	900 EH
Kinematic viscosity	$mm^2 . s^{-1}$	58	57	54	54
Total Acid Number	$mg . KOH.g^{-1}$	1,19	3	3,2	3,2

7. Removal of dangerous contamination from ecological fluid

In figure 4 we can see the content of chemical elements which contaminate the ecological fluid. The origin of the metal content as are Fe, Cu, Sn, Pb, Al is attributes to wear friction pairs. Silicium is an indicator of dust contamination, which it obtains into the system from external environment.To remove of dangerous contamination from fluid, we used the designed filter system. It was designed on the basis of components which were used in various devices and are still functional. These components can be founded in almost all agriculture farms in Slovakia. After this manner were given economics vantage and available solution. Price of bought filter cartridge is 5 €. Filtration ability of paper cartridge 10 μm and a maximum pressure 0,25 $kp.cm^2$. The basis of proposed filtration device is filter block Kovolis Hedvikov FS 32 – 10 connected to the outer hydraulic circuit of tractor. The filter device was connected to a hydraulic outside circuit by pressure hoses. Flow rate, pressure and temperature of fluid by Owatonna device were regulated, which is also connected to a hydraulic outside circuit

An analysis of parameters of tractor hydraulic parts for the purpose of research to improve their properties solved the authors of contributions in scientific journals Hujo [6], Drabant [2], Gurina [4], Kučera [8].

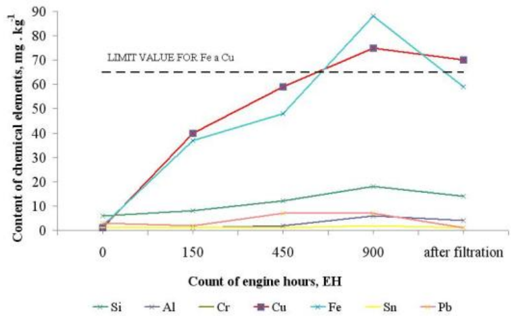

Figure 4 Evaluation of fluid contamination by IR spectroscopy

The picture shows the limit values of pollution for the elements Cu and Fe, which exceeded the limit values during the test. The concentration of Si was exceeded and concentration of Pb and Al was adjacent. After tractor running 900 Eh was applied designed filtration device, upon which there was a decrease in the concentrations of elements. Content of Fe decreased after filtration by 30%. Table 2 shows the results of measurements of cleanliness code by CS 1000 device. The device was attached to the filtration device during the filtration of ekological fluids. From value is obvious decrease character elements large than 14 μm, which shows by the correct functioning designed of filtration device.

Table 2 Evalauation of measurements cleanliness code

Measurement	Cleanliness code by ISO 4406		
	< 4 μm	< 6μm	<14μm
1.	24	23	10
2.	24	23	9
3.	24	23	8

8. Conclusion

The paper deals with testing of ecological gear-hydraulic fluid type MOL Farm UTTO Synt, applied in a Zetor Forterra 114 41 tractor which was preceded by an accelerated laboratory test performed on the Department of Transport and Handling, Faculty of Engineering. During the operational fluid test were sampled and its quality characteristics were rated. At the end of the operating test by revolution n = 1500 rpm decreased flow rate efficiency of the hydrostatic pump from value η_{pr0} = 96.89 % to value flow rate efficiency η_{pr900} = 95.73 %. Basically of decrease flow rate efficiency was achieved assessment of technical condition of UD 25 hydrostatic pump. Decrease of flow rate efficiency by revolution n = 1500 rpm after completing 900 Eh was $\Delta\eta$ = 1.197 %. MOL Farm UTTO Synt hasn't negative influence of durability hydrostatic pump type UD 25.

In pursing IR spectra was founded, that during the test of ecological fluid gave out a mixing of the new ecological fluid with the fluid contained in tractor additional device, which increased the level of fluid contamination. They were also detected values of kinematic viscosity, total acid number and water content, those didn't exceed the limit values after the test. We found by measuring, that after completing 900 Eh the fluid showed good physico-chemical properties, but were found above the limit levels of particulate pollution.

Based on this detection designed filtration device for the renewal of life of the fluid were applied. Content of Fe decreased after filtration by 30%. Positive effect of filtration are reflected by a decrease of cleanliness code for particles large than 14 µm about the two classes.

9. Acknowledgement

Supported by the Ministry of Education of the Slovak Republic, Project VEGA 1/0857/12 “Reduction of unfavorable impacts of agricultural and transport machinery on environment”.

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MEASUREMENT OF OPERATING PARAMETERS AND EMISSIONS OF TRACTOR WITH DIESEL OIL AND BIOFUEL

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Abstract
At the present are emission standards strictly limited and producer of tractors have to adapt to this situation and fill these strict norms. This paper is focused on mutual comparison and evaluation of operation parameters and emission of tractor with diesel oil and biofuel. Measurements were done on tractor Hűrlimann XB Max 100 on a test bench in laboratory of Agroscope Reckenholz-Tänikon. The goal of this paper was to evaluate of operation parameters and limited emissions by using standard hydrocarbon fuel as reference sample and biofuel.

Keywords:
operation parameters, limited emission, tractor, biofuel

1. Introduction

At these days, the diesel oil and petroleum products belong to the most using fuels. Because of its uncoverability, the crude oil is often called ‘the black gold’. Unfortunately, fossil fuels are non-renewable and exhaustible source of energy.

By the prognosis of Europe's Energy Portal, the real exhaustion of oil will be – 22nd of October 2047. The supply of natural gas is estimated up to year 2068 (EUROPE'S ENERGY PORTAL 2008). Society is really depending on gas and oil supply and its depletion could cause total collapse.

In European Union, there was made the strategy for utilization of renewable sources of energy and its using should grow to the year 2010 up to 12%. The expanded utilization of biofuels in transportation is also included into strategy and the aim is to 20% of fossil fuels replace by biofuels up to year 2020 [4].

The aim of this paper is to perform the operating parameters and emission tests to achieve the results about changes of these parameters by specific fuels including alternative fuel.

There were done a lot of works about different fuel characteristics. Scientists found out which alternative fuel could be the most appropriate to replace diesel oil. Considering the character of agricultural production, transport in agriculture significantly affects the economic effectiveness of the agricultural production [3, 12].

The most used tested fuels are crude vegetable oils made from rape seed, sunflower seed, soybeans, palm fruit and their esters. The power and torque of engine performance is lower about 3–6% for biodiesel. Fuel consumption is higher about 5–12% for biodiesel. There is also high smoke reduction (50%) and lower CO and HC for biodiesel. Values are higher for NO_x if use biodiesel. Generally, vegetable oils and their esters have strong potential to be used as an alternative fuel. Esters had good results and also if were blended with Diesel oil. But also RME (rapeseed oil methyl ester) can be used as fuel for DI (direct injection) engine without addition of different components or additives [10].

With today's rising fuel consumption, it is clear that issue of exhaust gases composition have and will have great importance. It is important to focus on choosing the measurement method, which gives us a complete overview about the emissions levels during the combustion of fuels [11].

2. Material and methods

To measure the operating parameters and emissions were realized on model of agricultural tractor –Hürlimann XB Max 100 (Fig.1) with following parameters:

Producer:	Same-Deutz Fahr
Engine:	Deutz 2012, TCD 2012 L04 2V
Number of cylinders:	4
Capacity of cylinders:	4038 cm^3
Bore/stroke:	101 mm/126 mm
Rated revolution:	2300 min^{-1}
Power:	72.5 kW
Injector pump:	Bosch Steckpumpen
Year:	2009
Runtime:	200 hours
Emission class:	Stage III.A
Specific:	100% biodiesel

Figure 1. Hürlimann XB Max 100 (Müllerová, Landis, Schiess: Agroscope Reckenholz-Tänikon Research Station ART and SUA in Nitra)

The measurements were done on a test bench in Agroscope ART - Tänikon. The next measurement devices were used:

- **Brake Schenck W700** – measured torque and power, through output shaft,
- **Filtermethod BOSCH** – measured smoke, utilization of filter layer with photo-element adapter, information in SZ Bosch (number of smoke places), smoke sonde on exhaust pipe,
- **AVL 733S** – measured fuel consumption, regulation in kg/h,
- **Matter Engineering NanoMet C with particle counter CPC 3010D from TSI** – measured particles in number/cm^3 in diluted exhaust gases then calculated values in number/kWh,
- **AVL – SESAM 4 (FTIR)** emission test system – measuring of limited and unlimited emission, values in ppm then calculated in g/kWh.

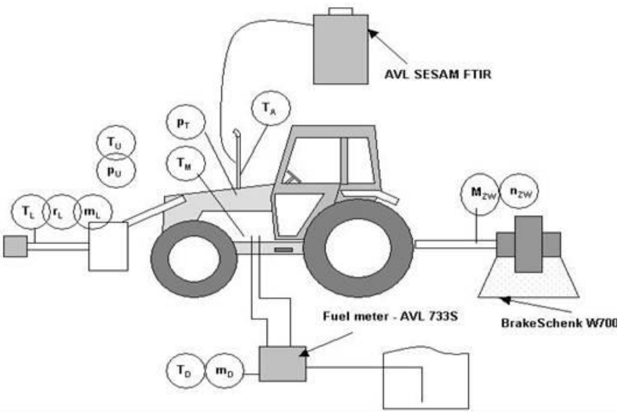

Figure 2. Sight of the test bench (Müllerová, Landis, Schiess: Agroscope Reckenholz-Tänikon Research Station ART and SUA in Nitra)

Used measuring devices were connected on the test bench, see Fig. 2. It shows specific connection of measuring devices with denoted parameters.
There were used two different samples of fuel for measurement - Diesel oil (SN 181160-1:2009) and RME (EN 14214) – from EcoEnergieEtoy, producer in Switzerland. In Tab. 1, there is analysis of used samples. Obviously, there are just small differences between both samples.
Oxidation stability of RME could be min. 6 hours but its value 5.2 hours is good and it should not cause any problems. Also, water and glycerol contain of RME are in limit. They meet the norm and both can be used as engine fuel.

Table 1. Analysis of used samples

ANALYSIS	abunit	limit	Diesel oil[1]	RME[2]
density by 15°C	kg/m^3	845.0	831.3	880.0
carbon	Mass. %	x	86.2	76.6
hydrogen	Mass. %	x	14.3	12.2
CFPP	°C	-20	-30	-17
flamepoint	°C	x	67.0	x
coldpoint	°C	-10	-10	x
sulphur contain	mg/kg	10	7.4	x
oxidability	hours	min. 6	x	5.2
acid value	mgKOH/g	0.5	x	0.19
water contain	ppm	500	x	256
glycerol contain	%	0.02	x	0.0035

Analysis by Intertek Caleb Brett - Switzerland, nr. 109026/02[1]
Analysis by CleanPal, s.r.o. – Slovakia, nr. 180110/D007 [2]

As measuring method, it was used norm ISO 8178-4, C1 (8 – points cycle). This norm is an international standard which is used for non-road engines.
By International Organization for Standardization (ISO), this norm specifies the test cycles for the measurement and the evaluation of gaseous and particulate exhaust emission from reciprocating internal combustion engines and it is applicable to engines for mobile, transportable and stationary use.

3. Results and discussion

On Fig. 3 there is presented the external revolution curve for Hürlimann XB Max 100.
We can see on the basis of external engine-speed map processed (Fig.3) differences between Diesel oil and RME characteristics.

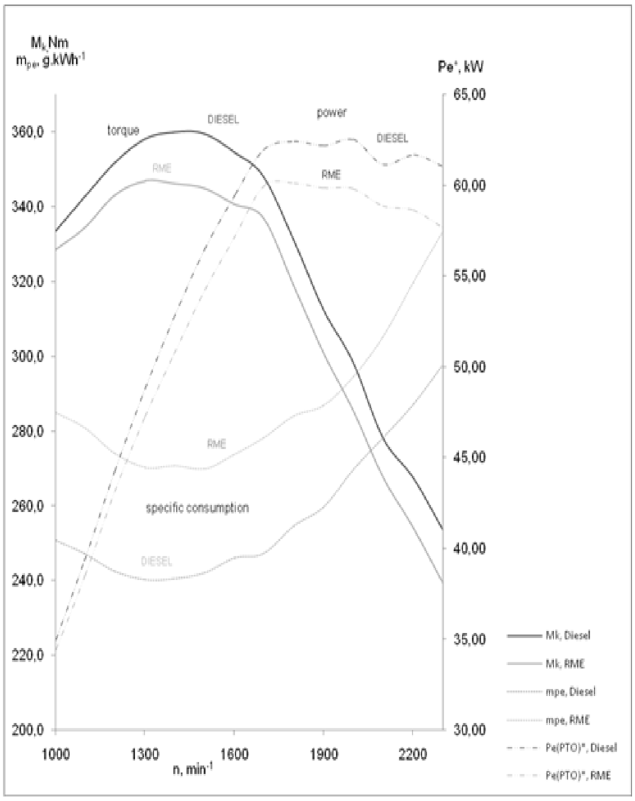

Figure 3. External revolution curve for Hürlimann XB Max 100

4. Measurement of limited emission

There were done measurement of tractor for limited emission which are – CO, HC, NO_x and Particle by ISO 8178-4, C_1 – 8 points test cycle norm. In Tab. 2, there are figured average values for each fuel based on PTO power. The graphic description is shown in Fig.4.

Table 2. Values of limited emission

Hürlimann XB Max 100	number/kWh	g/kWh		
	particle	CO	NOx	HC
Diesel	4.31E+14	1.05	5.09	0.19
RME	2.66E+14	0.91	5.92	0.13

* average value, based on PTO power

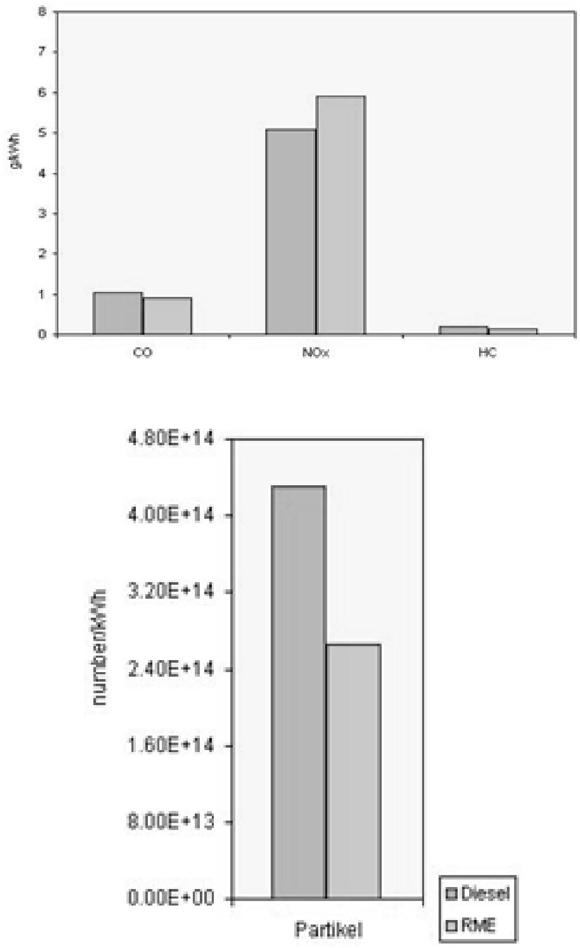

Figure 4. Limited emission values for Hürlimann XB Max 100

There was done also statistical analysis of limited emission by software Statistics. Based on the achieved results, there was chosen method of regulatory diagram for average and standard deviation. This diagram works with data measured on the output of process. Standard deviation is more effective indicator for variability of process, especially for bigger subgroup. But it is more difficult for calculation and it is less sensitive by detection of determinable causes of instability which individual unusual values in subgroups bring [1].

5. Conclusion

On the basis of external engine-speed map processed it is clear that power and torque were lower with RME compared to Diesel about of 5% and fuel consumption was higher with RME about of 10%. This was caused by lower thermal capacity of methylester (37.3 MJ/kg) in comparison with thermal capacity of diesel oil (42.5 MJ/kg). It is lower for RME about of 12%. But it is needed to reference also density of fuel this is by the

methylester (0.88 g/cm^3) and by the diesel oil (0.82 g/cm^3). That is increasing of methylester's density about of 7%. This is also reason of increasing fuel consumption by decreasing power and all of this has to be taking into account if compared individual results. Based on these facts, tested fuel can be marked as convenient for motor engines.
From the achieved results, it is possible to state the next facts. In every way, the emission of RME and Diesel are equivalent. The values of CO and HC and also particulate emission are lower for RME. But values of NO_x are lower for Diesel oil. Measured values are based on PTO power, so cannot be evaluated by Emission Standards for Off - Road Vehicles. If these measurements were done on engine tractor will meet the emission norm for CO and HC of RME and Diesel. The values of NO_x are higher about of 25% for both fuel than is determined the emission limit.

6. Acknowledgement

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CONSERVATION AND REVITALIZATION OF ENDANGERED GRAPEVINE CULTIVARS IN CROATIA AND MONTENEGRO AS A MODEL FOR SIMILAR EFFORTS IN HORTICULTURE

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Abstract
The South East European region hosts numerous indigenous (autochthonous) grape varieties which will irreversibly disappear in the near future if appropriate conservation steps will not be undertaken. In addition to obligate characterization and evaluation procedures it is necessary to ensure an effective cultivar preservation system linked to practical viticulture and nursery production. In order to prevent the ultimate loss of valuable genotypes of very rare and neglected indigenous varieties in Croatia and Montenegro and provide them with a chance of sustainability, multidisciplinary research and conservation actions were undertaken. A thorough survey was made through the available literature and available databases in order to choose locations of old vineyards for the field expeditions. Rare and neglected indigenous grapevine cultivars were detected and assessed for ampelographic and enological qualities. Tissue samples were collected for DNA fingerprinting and assessment of cultivar genetic variability was done using molecular markers. The level of virus infection was determined before the grafting on high quality virus-tested rootstocks for providing certified virus-tested stock material. Proper maintenance of material was ensured for future use in research and production by storing selected material in national and international *ex situ* repositories and nurseries. Results of research were uploaded in the European Vitis Database, upgrading the basic knowledge on the European *Vitis* gene pool. An overview of the project goals and results will be presented.

Keywords:
Conservation, grapevine, molecular markers, genotyping, virus-free

Introduction

The viticulture has a very long tradition and plays a significant role in the agricultural sector. Both, Croatia and Montenegro are countries that base their development on sustainable agriculture and strong tourism.

The strategy of tourism improvement relies on authenticity and unique natural resources. Local autochthonous crops and their products are an essential factor of this strategy. Among them, wine produced from local varieties has high recognition and potential. Some local varieties are either almost forgotten (reliable determination not possible, so called “no name” material) or they are, due to the lack of high performing virus-free propagation material, out of scope of commercial nurseries and producers. It is a very complex task, which requires an interdisciplinary approach and expensive facilities what could be very demanding for small developing countries passing transition such as Croatia or Montenegro. However, the importance of grapevine genetic resources for the national heritage of these countries and future breeding activities goes beyond national borders and hence, should be handled through international and interdisciplinary research.

Croatia and Montenegro are neighbouring countries sharing many similarities in viticulture and winemaking, both having numerous indigenous grape varieties only grown here and threatened to irreversibly disappear. This is particularly the case with local varieties restricted to a small area and which are either almost forgotten (reliable determination not possible) or they have a poor economic potential in the view of commercial grapevine nurseries, due to lacking high performing propagation material.

Developed wine countries have national institutes responsible for keeping repositories of all grape germplasm and doing permanent work on its maintenance in term of high genetic purity and health status. This is not the case in transitional Croatia and Montenegro. There are several national *ex situ* collections containing the majority of both Croatian and Montenegrin native cultivars. However, their establishment was hampered with numerous limitations. Usually, due to lack of funds,

the original vines used for propagation were not sufficiently studied and the vine health status was not criteria for propagation.
Some preliminary studies showed that old native varieties are massively infected with multiple viruses. Some very rare and underutilized genotypes, usually not considered as economically important for Croatian wine makers, such as Crljenak kaštelanski (Maletic et al., 2004) or Malvasia dubrovacka (Crespan et al., 2006) turned out to be quite relevant in some foreign countries. The same was noticed in Montenegro with cv. Kratosija (Calo et al., 2008). This clearly shows that the present level of utilization is not necessary the indicator of cultivar quality and economic potential.
In order to ensure preservation of national grapevine genetic resources, it was necessary to ensure proper funding. This was achieved through establishment of the international consortium within the SEE-ERA.NET PLUS projects financed by the European Commission. The goal of SEE-ERA.NET PLUS was further integration of the Western Balkan Countries (WBC) and its key research communities into the European Research Area (ERA). The ERA-91 consortium was made of four members, two of which were from EU (Germany and Austria) and Croatia and Montenegro from WBC. Partner institutions were: University of Zagreb, Faculty of Agriculture as a coordinator, University of Natural Resources and Applied Life Sciences Vienna (BOKU), Geisenheim Research Center (FAG) and University of Montenegro, Biotechnical faculty (BTF). Each partner was in charge of specific activity within their area of expertise. The role of partners and overall goals can be seen from the Chart 1.

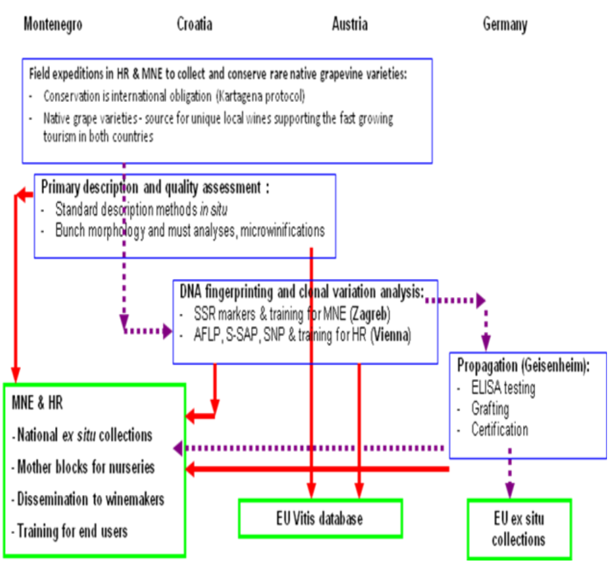

Chart 1. Brief review of project goals

Method
Because conservation of endangered cultivars is a very complex task, numerous methods have been used in order to achieve final goal.
After studding available literature and deciding about locations, field expeditions were taken in order to tag, describe and take samples from interesting vines for further analyzes.
Samples of young leaves from Croatia and Montenegro were used for extraction of DNA in the laboratory (E.Z.N.A. SP Plant DNA Kit, Omega Biotek, Doraville, USA). Part of the DNA was used for DNA fingerprinting (establishment of cultivar genetic profiles) and other part for analyses of inter and intra-varietal variability. Cuttings from both countries were sent to the partner institution FAG for virus testing and grafting. The grapes collected from chosen cultivars were used for microvinification in Croatia and Montenegro separately following the agreed standard procedure.
Microsatellites markers (SSR) have been used for identification of grapevine cultivars. We have chosen nine standard SSR markers for DNA fingerprinting along with their protocols as previously used by consortium of EC GrapeGen06 project (https://www1.montpellier.inra.fr/grapegen06/).
SSR genotyping was performed using Veriti ™ Thermal Cycler (Applied Biosystems, Foster City, USA) and ABI 3130 Genetic Analyzer (Applied Biosystems, Foster City, USA).
A modified S-SAP (sequence-specific amplified polymorphism) method by Wegscheider et al. 2009 with universal primers for retrotransposons was used to study the clonal diversity of the grape from Croatia and Montenegro.
Presence of plant viruses was assessed within collected material and sanitary selection was done using accurate laboratory tests. Standard visual selection, followed by lab tests such as ELISA and PCR for main virus diseases such as ArMV, GFLV, GLRV-1, GLRV-3 was used to asses the health status of sampled cultivars and estimate the level of infection in farmers' vineyards. The virus-free material of all cultivars, especially those that are economically important or with significant enological potential was propagated to provide certified stock material. It was done according to highest standards in plant material production using the best appropriate rootstock material available (Paulsen 1101 and Kober 5BB).
During selection, the primary and some secondary OIV ampelographic descriptors were recorded (cluster and leaf characters) in order to produce the phenotypic profile (including high quality photos) of all collected varieties.

Each selected vine was labelled and positioned both by GPS device and standard location passport data to enable subsequent analyzes and repeated sampling if necessary.
One of the project goals was to produce single variety wines in order to increase the quality and change the perception of the variety in the eyes of the producers. The microvinification of 6 Croatian and 4 Montenegrin cultivars was performed in each country for each variety in experimental facility. The wine samples were subject of standardized lab and sensory evaluation performed by panel of experts from project consortia.
After all analyzes have been done, results were checked and analysed statistically.

Results

Every member of this consortium contributed to the final goal, conservation of endangered cultivars, through the specific project deliverables. The results are represented trough the example of one genotype, variety Sansigot.
After a thorough literature survey, field expedition was organized to 12 locations in Croatia and 7 in Montenegro. All together 39 accessions (assumed as different genotypes) represented by 265 vines have been tagged, ampelographically described, photographed and sampled for DNA analysis. PCR protocol has been optimized for 9 SSR markers and subsequently all available samples have been genotyped. Analyses have shown that 26 different genotypes were found. Example of an accession, assumed and confirmed as one genotype (Sansigot) and represented by 9 vines (samples), is shown in the Table 1.

Table 1. SSR markers and virus testing results for Sansigot

				SSR MARKERS																	
LAB CODE	VARIETY	LOCATION	VIRUSES	vvs2		md7		md27		zag62		zag79		md5		md25		md28		md32	
SEE 31	SANSIGOT	KRK	VIRUS FREE	141	141	237	247	175	175	187	199	234	252	222	222	237	253	252	256	252	264
SEE 32	SANSIGOT	KRK	LRV1,LRV3	141	141	237	247	175	175	187	199	234	252	222	222	237	253	252	256	252	264
SEE 33	SANSIGOT	KRK	GFV	141	141	237	247	175	175	187	199	234	252	222	222	237	253	252	256	252	264
SEE 34	SANSIGOT	KRK	VIRUS FREE	141	141	237	247	175	175	187	199	234	252	222	222	237	253	252	256	252	264
SEE 35	SANSIGOT	KRK	AMV,LRV3	141	141	237	247	175	175	187	199	234	252	222	222	237	253	252	256	252	264
SEE 36	SANSIGOT	KRK	VIRUS FREE	141	141	237	247	175	175	187	199	234	252	222	222	237	253	252	256	252	264
SEE 37	SANSIGOT	KRK	VIRUS FREE	141	141	237	247	175	175	187	199	234	252	222	222	237	253	252	256	252	264
SEE 38	SANSIGOT	KRK	VIRUS FREE	141	141	237	247	175	175	187	199	234	252	222	222	237	253	252	256	252	264
SEE 39	SANSIGOT	KRK	GFV	141	141	237	247	175	175	187	199	234	252	222	222	237	253	252	256	252	264

The insight in intra-varietal variation is very important when working with very old and previously not selected varieties. Due to accumulation of mutations, individual vines can differ greatly from the population mean. Assessment of mutaitons level should provide the insight in homogeneity of cultivar population and indirectly point on capacity and necessity of clonal selection in the future.
All 265 samples were analysed for intra-varietal variability via 6 S-SAP markers (with *Mse*I and universal retro-*transposon primers*).

All cuttings were tested for five economically important virus diseases (ArMV, GFLV, GLRV-1, GLRV-3, RRSV) and 81 samples of all cultivars were virus-free and was sent for grafting together with some cuttings with significant enological potential or those economically important. It can be seen on the example of Sansigot, where five of nine samples were virus-free (Table 1.).
At the end of propagation procedure 235 grafts were produced and sent to Croatia and Montenegro to be used as certified stock material. It is expected about 500 grafts from second project year.
The phenotypic profile (including high quality photos) of all different varieties was done using standard 24 OIV ampelographic descriptors (cluster and leaf characters) as it can be seen in Table 2. for Sansigot.

Table 2. Standard OIV descriptors for Sansigot

Sampled genotypes ERA91/01	Ampelographic descriptors (OIV)																						
	3	4	51	53	67	68	70	79	80	84	87	151	153	155	202	204	208	223	225	235	236	505	506	508
SANSIGOT	1	1	3	1	2	3	1	3	2	1	3	3	2	5	3	7	1	2	6	3	1	1	3	5

Prior to microvinification of 6 Croatian and 4 Montenegrin cultivars, standardized evaluation of cluster, grapes and must was done.
Also, standardized analyses of sensory and chemical characteristics of wines were done for all the wines in microvinification.
In accordance with the plan, two on-hands one-month trainings were held. The training for DNA fingerprinting was held in Zagreb for Montenegrin partner, and training of inter and intra-varietal variability was held for Croatian partner in Austria (see Chart 1.). The purpose was exchange of knowledge which is important for adapting Western Balkan Countries to the European Research Area.

Discussion

The project ERA-91 has achieved most of its objectives and technical goals for the period with relatively minor deviations. During the project, there were some obstacles, challenges and delays that made project management more demanding. Most of the problems occurred due to late start of the project, not coordinated with the vegetation season. Due to late sampling time (senescence of leaves started) success of DNA extraction and planned genotyping was about 80% so; about 20% of tagged accessions, mostly from Montenegro, had to be repeated in the second project year what was successfully overcome.
Also, grape quality assessment and microvinification had to be postponed for next project year since the project funding started after the harvest.

Due to the problem with DNA extraction mentioned earlier, analysis of intravarietal variability only started in May and was further delayed because of the moving of the partner institute to a new location. The unexpected problems with the ELISA resulted in addition working hours for the technician employed for the project and more ELISA kits. Grafting success was increased during second project year by better scion material (no hail damage). Some interesting materials were virus infected, but was decided to be grafted as well. Apart from those technical challenges, consequently, there were delays and obstacles in fund spending. Everything has been resolved as it appeared, thanks to the excellent communication with the EU SEE-ERA.NET PLUS office. Harmonisations between national and EU regulations were quite demanding.

Conclusion

Complexity of the task of preserving indigenous grapevine cultivars requires multifunctional and multidisciplinary solutions to numerous problems. In order to achieve conservation and sustainability of endangered cultivars in the terms of modern agricultural production it is crucial to undertake few general actions. First it is necessary to find out where the origin of the endangered cultivar is or where it can still be found. It is crucial for organizing field trips in order to collect samples for genetic identification and propagation. Once rare and neglected indigenous cultivars are genetically indentified, labelled and assessed for its characteristics, qualities and health condition, healthy propagation material needs to be produced. Proper funding is necessary for achieving conservation and revitalisation of the endangered cultivars. Sustainability of such efforts requires implementation of findings in production and turism in accordance with a growing demand for distinguished local products that could be (if available) placed on the regional market, focusing on visiting tourists.
Project consortium of ERA-91 succesfully fulfilled their project obligations and managed to achieve defined goal: conservation and revitalisation of endangered grapevine cultivars in Croatia and Montenegro.

Acknowledgement

This project (“Preservation and establishment of true-to-type and virus free material of endangered grapevine cultivars in Croatia and Montenegro”) was financed by the European Commission and supported by the SEE-ERA.NET PLUS consortium.

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TOTAL AND AVAILABLE YIELD OF SOYBEAN RESIDUES

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Abstract
Soybean straw is favorable renewable energy source in Vojvodina and the region of Pannonia plane. Amount of harvestable residues per hectare, straw, is not well known. An excessive offtake of soybean residues may cause negative impacts, regarding soil fertility, removal of nutrients, soil organic carbon, erosion etc. The objective of the research was to determine amount of soybean crop residues, harvestable and remained on the field.
Samples of above-ground mass, six representative soybean varieties from three locations in Vojvodina, were collected. The samples were divided into following plant parts: grain, stalks, branches/leaves and hulls. The harvest index, yield and relative yield of crop residues were determined. The common straw harvesting practice was considered.
Average harvest index is 0,47. The percentage of harvestable residues is between 41 and 48 % of total. Residual above-ground biomass can, in most of cases, ensure reduction of wind erosion. Future researches should quantify uptake of nutrients by straw harvest, as well as other possible negative effects on soil fertility. The obtained results are suitable background for determination of maximal soybean residues offtake and creation of sustainable residues management.

Keywords:
Soybean, residues, energy, soil

1. Introduction

Soybean is significant arable crop and important proteins' source. World grain production is between 210 and 260 million Mg. Following the World and EU trends, especially directive 2009/28/EC, soybean residues, namely straw, is considered as favorable recourse of renewable energy. Martinov et al. [1] provided potential of soybean straw of about 280.000 Mg per annum in Province Vojvodina, agricultural part of Serbia. The soybean straw has net heating value 15 to 16 MJ kg^{-1} (moisture content 14 %), which overcomes values of other crop residues. The partly higher value is due to certain amount of oil contained grain (losses) in harvested straw.
Utilization of soybean straw as energy source is practiced in Vojvodina and the region of Pannonia plane, Kis et al. [2]. It is primarily used for the heating of family households, but for process heat generation as well. The possibility of pyrolisis is investigated by Boateng et al. [3].
The removal of crop residues from the field has potentially negative impacts as well. Residues contain certain amount of macro and micro nutrients, they are source of organic mater, Powlson [4], contribute improvement of soil structure and characteristics, and reduction of water and wind erosion. This means, that the removal of crop residues should be performed in sustainable manner, to prevent degradation of soil fertility and diminishing of positive contributing microorganisms.
Jay and Izaurralde [5] declared that decreases of soil carbon (approximately 40-90 kg C ha^{-1} year^{-1} per Mg of residue harvested); and decreases soil nitrogen (~3 kg N ha^{-1} year^{-1} per Mg residue harvested) should be expected. Some publications gave only general hints in this concern, e.g. to remove one third of residues, Brkic and Janic [6]. Still, it was not justified if this is related to the available over-ground biomass or harvestable. Another statement, mostly related to balance of soil organic carbon, SOC, recommends to incorporate all residues into soil if its content of organic mater is low, Sekulic et al. [7]. Other sources stated that most of organic carbon is located in the root and rhizosphere, up to 80 %, Allmaras et al. [8]. It implies that the offtake of above-ground crop residues does not impact SOC reduction to high extent.
There is neither common practice, nor general recommendation for reasonable and sustainable crop residue management. Proper crop residues' management is specific for local agro-ecological conditions, particular crop and its rotation etc., Rosentrater et al. [9].
Even more, there are missing realistic data on harvestable residual biomass, if common harvest procedure is performed for most field crops and for soybean as well.
The amount of nutrients, first of all nitrogen, phosphorus and potassium, is well elaborated for corn stover, e.g. Johnson et al. [10], but not for soybean straw. In the same publication, costs of removed nutrients are given: 18,1, 17,6 and 11,7 US$/Mg for below-ear stover, above-ear stover and cobs, respectively. The costs of removed nutrients should be included in the calculation of residual price, including soybean straw.

Therefore, the main objective of performed research was to quantify total and harvestable above-ground biomass of soybean residues and influence of its removal on erosion. The results can be used as background for decisions related to soil fertility preservation, costs assessment of removed nutrients, and generally for the development of sustainable soil management procedure.

2. Materials and methods

The samples of six representative varieties of soybean, grown in Province Vojvodina: Venera, Sava, Balkan, Galeb, Gorstak and Vojvodjanka, were taken from three locations with slightly different agro-ecological conditions in 2011. From each plot, in the stage of grain maturity, five randomly distributed samples from one square meter have been taken, total above-ground mass. Each sample was separated into following parts: grain, stalks, branches/leaves and hulls. Their mass was measured using balance with accuracy of 0,1 g. This was followed by measuring of moisture content of all parts. The procedure for moisture content measuring was in accordance with ASAE S352.2 [11] for grain and ASAE S358.2 [12] for other parts. The dry matter yield of all parts was calculated based on measured mass and moisture content. Harvest index and relative yield (related to grain) were calculated.
Stalks were cut into four sections, lowest 7,5 cm, 7,5-15, 15-22,5, 22,5-30 and above 30 cm. The data were used to create cumulative mass diagram along the stalks' height. This was used to assess stalk mass that remained on the field, stubble, after the harvest using certain combine harvester cutter bar height.
Usual soybean straw harvesting practice, baling, was considered in order to determine common losses of residual material by this procedure.
In the Pannonia plane region, considering wind erosion is of great importance. The minimal amount of crop residues which ensures reduction of wind erosion is defined by ASAE EP291.3 [13]. This is 1.100 kg ha^{-1} of small grain residue equivalent. The specific value for soybean residues was determined using conversion diagram given by Hickman and Schoenberger [14].

3. Results and Discussion

The results are presented in tab. 1.

Table 1. Obtained results (mass for dry matter)

	Grain			Stalks		
Variety	W	Y	HI	W	Y	RY
Venera	9,06	3,01	0,43	18,57	2,07	0,69
Sava	8,06	6,99	0,54	10,44	3,13	0,45
Balkan	8,50	5,88	0,44	10,48	2,77	0,48
Galeb	8,60	3,37	0,51	12,91	1,74	0,52
Gorstak	11,41	2,70	0,45	33,47	1,62	0,60
Vojvodjanka	11,30	6,56	0,45	12,79	3,63	0,55
Average	9,49	4,75	0,47	16,44	2,50	0,55
SD	1,36	1,77	0,04	8,08	0,74	0,09
	Branches/leaves			**Hulls**		
Variety	W	Y	RY	W	Y	RY
Venera	13,02	0,40	0,13	12,82	1,54	0,51
Sava	11,18	0,85	0,12	11,04	2,03	0,29
Balkan	11,67	2,52	0,43	10,06	2,26	0,38
Galeb	12,64	0,27	0,08	10,42	1,27	0,38
Gorstak	21,56	0,56	0,21	13,20	1,06	0,39
Vojvodjanka	12,69	2,15	0,33	9,02	2,14	0,33
Average	13,80	1,12	0,22	11,09	1,72	0,38
SD	3,53	0,88	0,12	1,49	0,45	0,07

W– moisture content in %. Y– yield in t ha^{-1}. HI– harvest index. RY– yield relative to grain. SD– standard deviation.

The all samples were taken from the plots of farms with advanced technology, what resulted with high average grain yield, 4,75 Mg ha^{-1} of dry mater. Harvest index of almost 0,5 is typical for high grain yield. Based on harvest index the average yield of above-ground residual biomass is 5,36 Mg ha^{-1}, dry mater. The percentage of residues parts– stalks, branches/leaves, hulls is 48:19:33 %.
Fig. 1 presents distributions of stalks cumulative mass for all varieties, and fig. 2 average values for all tested varieties and sites.

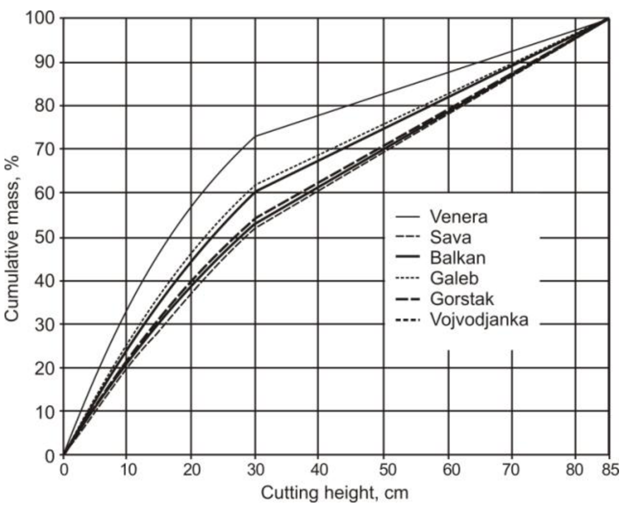

Figure 1. Assessed soybean stalks cumulative mass distribution along the height

The mass distribution along stalks, cumulative mass, shows similarities for most of tested varieties. The only significant difference shows variety Venera.

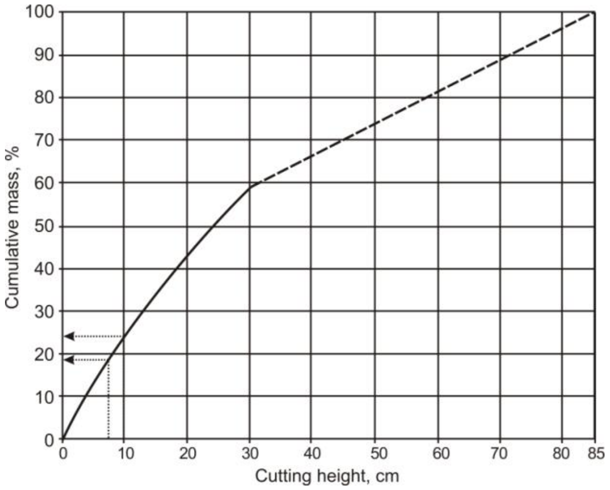

Figure 2. Assessed soybean stalks cumulative mass distribution along the height, average

For the harvest of soybean, the low cutting height is commonly applied, aiming to reduce high losses, which are typical for this crop. The percentage of stalks mass remaining on a stubble are, in average, 18,6 % for cutting bar height 7,5 cm, and 24,1 % for cutting bar height 10 cm. That means, for the cutting heights 7,5 and 10 cm, dry matter mass of 2,04 and 1,90 Mg ha^{-1}, respectively, will be available. Most of branches/leaves and hulls fall down, but some are mixed with cut stalks. If the share of these parts is 20 %, it makes additional 0,57 Mg ha^{-1}, or total mass 2,61, i.e. 2,47 Mg ha^{-1}. Baler loses, i.e. pick-up device, are about 10 % in average. Finally, the harvested biomass is 2,35 and 2,22 Mg ha^{-1}, for cutting height 7,5 and 10 cm, respectively. The remaining residual biomass is than 3,01 and 3,14 Mg ha^{-1}, dry matter.

The mass of soybean residues equivalent for 1.100 kg ha^{-1} of small grains residue is about 1.300 and 1.700 kg ha^{-1} for standing and flat soybean residues respectively, according to Hickman and Schoenberer [14]. The same source provides data about reduction of cover plant material after certain operations and weathering. For example, during the winter, the covering mass is reduced by 30 %. It is clear that remained soybean residue is sufficient to reduce wind erosion, but not, in all cases after the winter weathering reduction.

Even if the share of harvested branches/leaves and hulls would be higher, e.g. 30 %, only up to 48,5 % of above-ground residual soybean biomass will be harvested. This result is comparable with similar research performed for harvest of wheat residues, where the harvested biomass was 48 % of total, Golub et al. [15]. Generally, harvestable soybean above-ground residues are in the range 41 and 48 %, and remained biomass can ensure reduction of wind erosion.

These results can serve for the calculation of soybean straw potentials, as well as for definition of reasonable maximal residues offtake.

8. Conclusion

Soybean straw is becoming, for several reasons, attractive renewable energy source, in the region of Pannonia plane, but World wide as well. Crop residues' management should be performed in sustainable manner in order to prevent degradation of soil fertility. One of important things is to know available, harvestable amount of soybean straw. The best is to know harvest index and expected straw harvest losses.

Provided research resulted with data on harvest index, average 0,47, and share of residues parts in above-ground residual biomass. The percentage of stalk, branches/leaves and hulls in residual mass is 49, 19 and 33 %, respectively.

Obtained cumulative mass distribution along stalks, starting from ground, enabled assessment of stubble mass (non harvestable), depending on cutter bar height. It is for height 7,5 cm– 18,6 and for height 10 cm– 24,1 %, in average.

The percentage of harvestable residual biomass, straw, depends on many influences. It is expected to be between 41 and 48 %. Remained above-ground mass in many cases enables reduction of wind erosion.

In the future, the experiment should be repeated in order to obtain more realistic data, for different weather and crop conditions.

Research on estimation of nutrient removal with soybean straw should be performed as well, and these costs should be added when defining straw selling price.

The collected data can support development of sustainable soybean residues management for farming specific conditions.

9. Acknowledgement

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MONITORING OF PESTS IN CROATIAN FORESTS FROM 2002 TO 2009

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Abstract
Forest is a unity of trees, shrubs and wild animals, which favourably affects all aspects of life. The importance of forests is reflected in its natural renewable resources. Croatian territory represents the boundary between North American-Siberian and Mediterranean regions where more than 60 forest phytocoenoses can be distinguished. The great wealth of forest communities and forest species are often exposed to various harmful forest insects. The main cause of the attack of insects in the forest is their need for food. The greatest damage to our forests are insects that cropping the leaves and punching the trees. The most important pests of Croatian forests in the period from 2002 to 2009 are: gypsy moth, crocuses, ash pipe and oak folder.

Keywords:
forests, monitoring, pests, gypsy moth, oak folder

1. Introduction

Forest as a community of trees, shrubs and wild animals is an ideal habitat for the living world and the most complex ecosystem on the planet. What makes it indispensable for forest protection and improvement are the beneficial functions of forests such as the protection of soil from erosion by wind and water, water balance relationships in the landscape, purifying water percolating through a forest soil and underground water supply and drinking water sources, favourable impact on climate and agricultural activity, purification of polluted air, the impact on the beauty of the landscape, creating favourable conditions for human health, biodiversity of species, ecosystems and landscapes, alleviating the impact of greenhouse gases through carbon sequestration and oxygen enrichment of the environment, etc. [1]. Croatian territory represents the boundary between North American-Siberian and Mediterranean regions where more than 60 forest phytocoenoses can be distinguished. North American-Siberian region includes the continental part of the Croatia, while the Mediterranean-littoral zone covers most of the islands, a narrow coastal belt and central and southern Dalmatia. The continental part of the Croatia is characterized by deciduous forest, with the following major forest species: red oak (Quercus robur L.), field ash (Fraxinus angustifolia Vahl), alder (Alnus glutinosa L.), hornbeam (Carpinus betulus L.), white and black poplar (Populus alba L. and P. nigra L.), various species of willow (Salix spp), sessile oak (Quercus petraea L.), chestnut (Castanea sativa Mill), birch (Betula pendula Roth), oak (Quercus cerris L.), oak (Quercus pubescens Willd), maple (Acer campestre L.), wild cherry (Prunus avium L.) and beech (Fagus sylvatica L.). In the Mediterranean area there are the evergreen forests of holm oak (Quercus ilex L.) and Aleppo pine forests and the Dalmatian black pine (Pinus halepensis Miller and Pinus nigra Arn. Subsp. Dalmatica Vis.). Forest insects are the most important harmful organisms that deplete the forest trees. In favourable conditions they can make large and diverse claims. The most important Croatian forest pests are gravediggers (Gryllotalpa gryllotalpa L.), common cockchafer (Melolontha melolontha L.), sixgill gypsy moth (L. dispar Limantria), beetles (Cerambycidae spp), weevils (Curculionidae spp), humps (Geometridae spp), folder (Tortricidae spp) and others [2].

2. Monitoring of forest pests from 2002 to 2009

The presence of pests depends on the quantity of food, population of natural enemies and climatic conditions. During the winter and early spring about 450 samples of oak branches were analysed and based on the results, the measures for the protection of oak defoliators were proposed [3]. Since 2002 pests that were regularly monitored in Croatian forests were the following: crocus fam. Geometridae, ash pipe (Stereonychus Fraxino De Geer), oak folder (Tortrix Viridiana L.), and since 2003 sixgill gypsy moth (L. dispar Limantria). Size of forest area in Croatia attacked by crocus is shown in Figure 1. The emergence of crocuses in Croatian forests was relatively uneven throughout the observed time period. In 2005 the number of infected surface has reached the highest limit value in the observed time period. Reduce of infested areas was observed in 2006 while in period from 2007 up to 2009 the number of damaged forest areas from year to year has increased again.

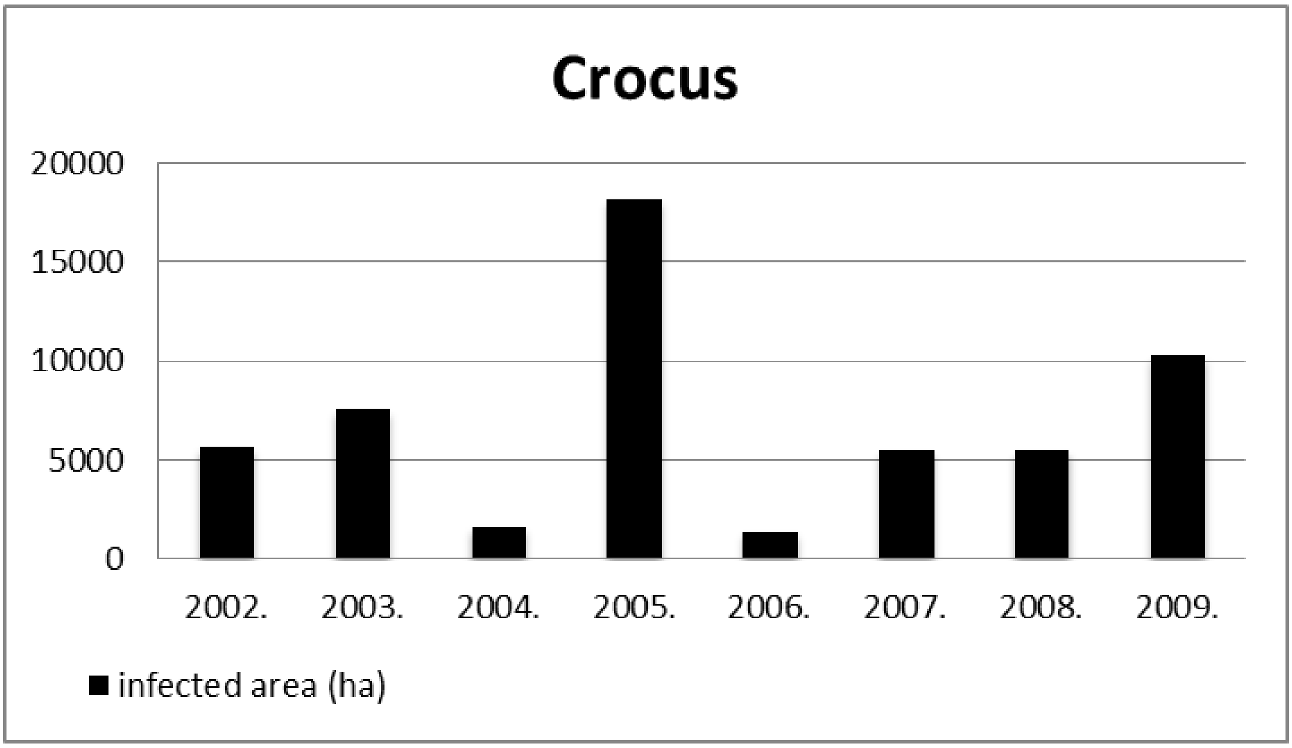

Figure 1. Forest area in Croatia attacked by crocuses in period from 2002 to 2009

Oak folder is one of the early harmful insects that appear at the time of listing. It is important to emphasize that the oak folder appeared on the same surfaces as well as Meadow Saffron. In 2003 area that was exposed to attacks of oak folder reached the maximum limit value of the reference period. After that the affected areas were reduced (Figure 2).

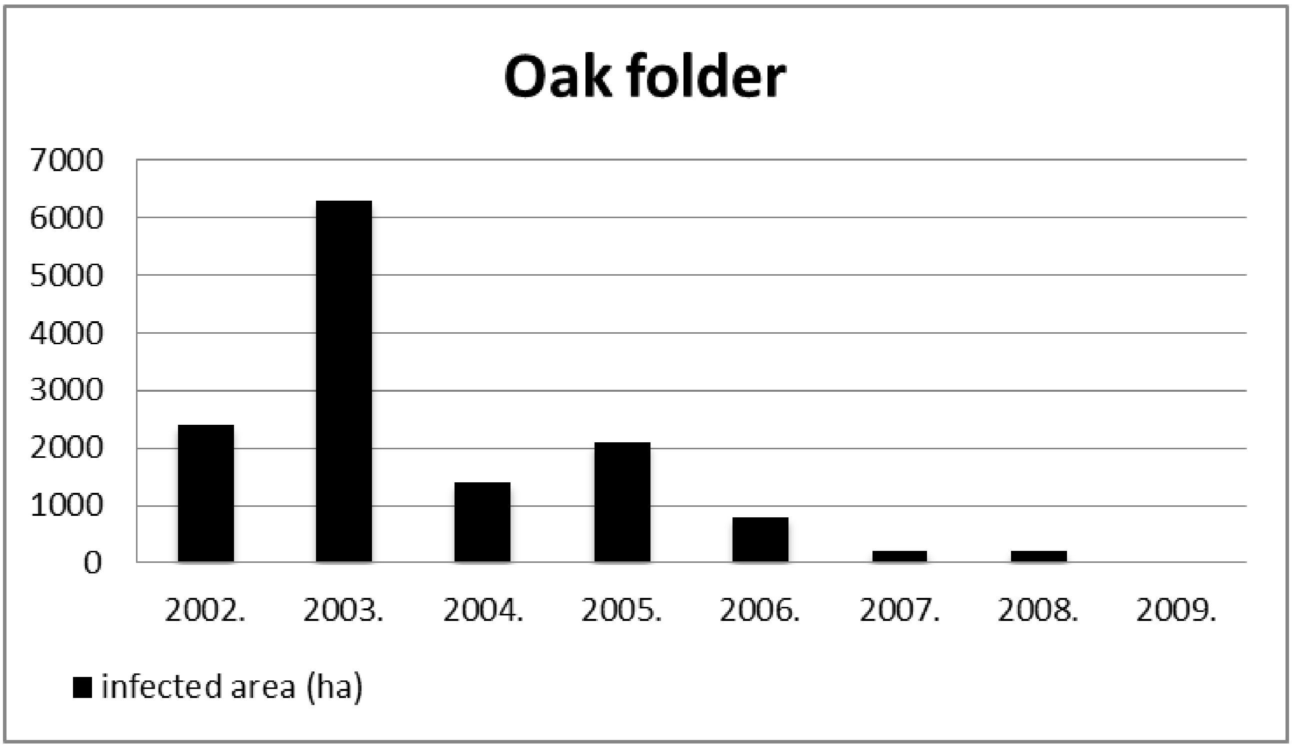

Figure 2. Forest area in Croatia attacked by oak folder in period from 2002 to 2009

Ash pipe is a pest of ash that regularly occurs on ash trees in the inland forests. Size of forest area in Croatia (expressed in hectares) affected by the ash pipe are shown in Figure 3. Presence and intensity of attacks in the period from 2002 to 2008 was relatively uniform and in year 2009 there was a significant increase in the affected area and intensity of damage [3].

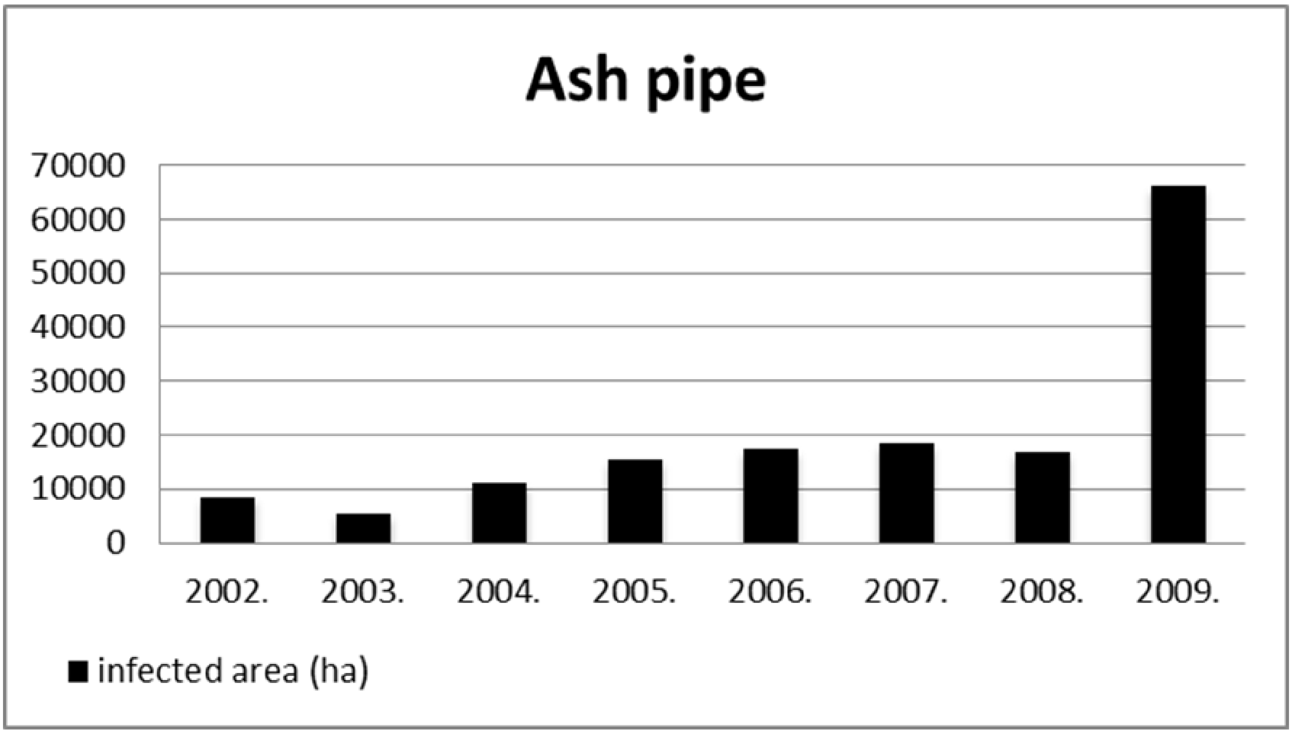

Figure 3. Forest area in Croatia attacked by ash pipe in period from 2002 to 2009

Gypsy moth population reached the climax in year 2005 (Figure 4). In the period from 2006 to 2008 a reduction in the area infected by this pest was observed. Gypsy moth population in year 2009 was in the latency phase (resting).

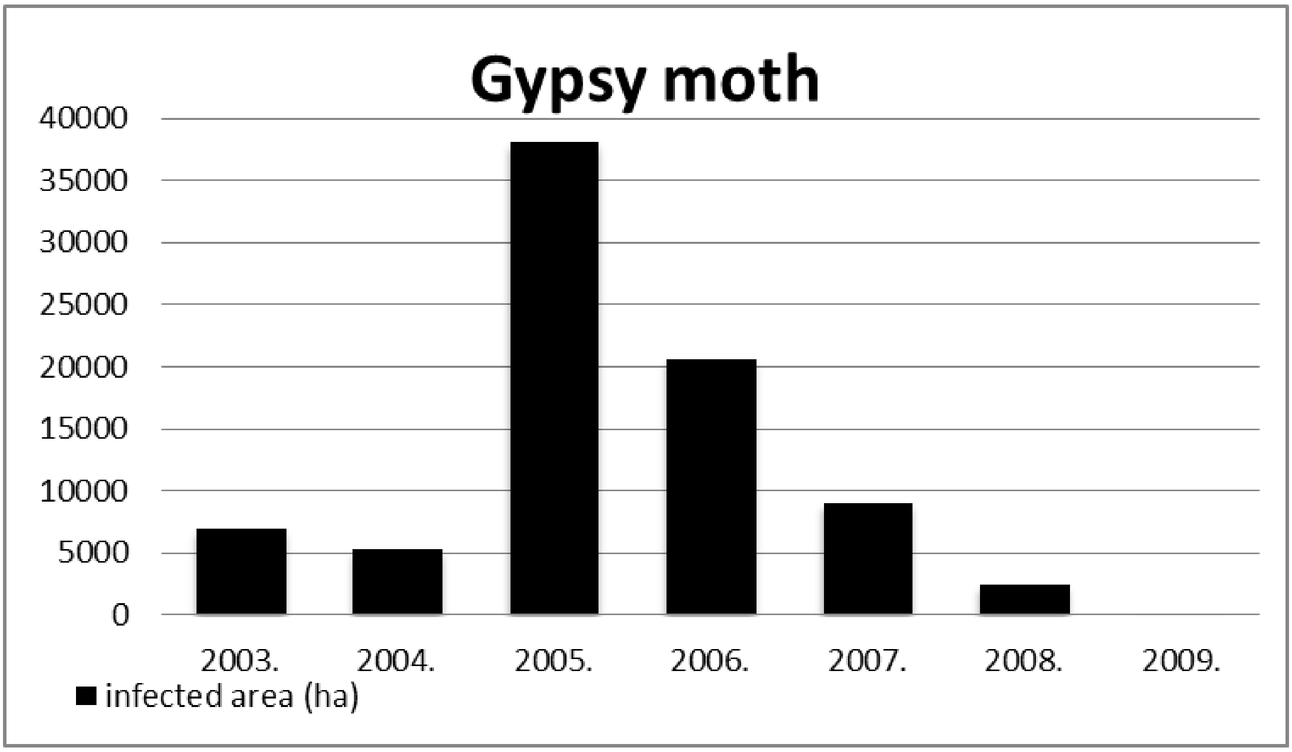

Figure 4. Forest area in Croatia attacked by gypsy moth in period from 2002 to 2009

3. Conclusion

Many forest species in the Croatian forests are often vulnerable to different insects. Forest insects are the most important harmful organisms that deplete the forest trees. In the period in which insects' population was monitored, increase of area attacked by pests was observed in case of ash pipe and crocuses, while for the gypsy moth and oak folder decrease was noticed. Gypsy moth infested area has reached its culmination in year 2005 and it was 38 047 ha. There has been a steady increase in areas infected by ash pipe. That area in year 2002 was below the 10 000 ha just to increase to 66 000 ha in total in year 2009. Oak folder, as an early oak defoliator, did the damage together with the crocuses in oak forests. His rise in 2003 reached the maximum limit value, and there was 6300 ha infected, while in year 2009 attack of this pest was not recorded over large areas. The most important pests of Croatian forests in the period from 2002 to 2009 were: gypsy moth, crocuses, ash pipe and oak folder.

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THE SPATIAL ANALYSIS OF ST.ANTHONY'S SQUARE PARK IN PODVINJE

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Abstract
The spatial analysis of St. Anthony's square park in Podvinje was done to improve the parks qualitative features. Inventory of plant material, measuring, photographing and inspection of street furniture were made by field work. The spatial analysis is the starting point for future interventions in the area. Measures of care and rehabilitation are proposed due to the fact that the park has ecological, sociological and aesthetic value for residents of Podvinje.

Keywords:

spatial analysis, park, inventory, plant material, urban equipment

1. Introduction

Parks are important parts of urban greenery and lifestyle indicator of population. In the city of Slavonski Brod, one can find a number of parks, but often they are rudiments of the original ideas that because of the subsequent work in the area seem not to justify their worth.

Usually, city-owned parks are entrusted to the care and maintenance of communal organizations, but a large number of parks have become disordered park forests due to reduced costs [1].

Particularly vulnerable are the parks that are not in the city center. The old trees are, due to mechanical damage, soil compaction and improper closure of the root zone, aesthetically unacceptable and lose vitality [2]. This is why we agree with Obad Šćitarocij that says: "Quantitative meets the standards of public squares of green area per capita" overcome the quality facilities that would provide needed space to users, through a variety of plant materials, street furniture and landscape plastic [3].

St. Anthony's square park in Podvinje (Fig. 1.) is a typical example which confirms the thesis of Šćitarocij Obad. The additional work on parking spaces traumatized the vitality of trees. The spatial analysis is the first step which aims to draw attention to the current situation in order to take adequate steps and make a quality improvement. "As greens (as seen on the biological level) have a development and duration, and on the spatial level need for formal sustainable architecture, it will be necessary to do interventions and reconstruction" [4]. Therefore, this paper has the purpose of initial measurement and inventory of plant materials in order to achieve more extensive spatial analysis.

Figure 1. *St*. Anthony's *square park in* ARKOD browser (25 m)

2. Materials and methodes

The park is located in the center of Podvinje's St. Anthony square 1. It belonged to the municipality of Podvinje which is now an integral unit of the city of Slavonski Brod. Cadastral designation particle is 4375.

Field operations conducted the following activities: inventory of plant materials, measuring, photographing and inspection of street furniture.

A spatial sketch is made and the existing plant species are determined which is shown in Table 1. The park was photographed in October and May. Tree trunk diameters and canopy of trees were measured. The inspection showed that there is some damage to trees, as for tree trunks, and so for some parts of the canopy.

The photographic material, other than plant material also contains details of street furniture (benches, waste bins and monuments).
The park plan with the trails and trees placement was made digitally by using AutoCAD programme (Fig.2.).

3. Results

The Park is rectangular in shape and is situated on the slopes of southern exposure. The park is designed for relaxation and fun for people in Podvinje. Visitors to the park are mostly mothers with preschool-age children and adolescents. On the south side of the park passes the main Podvinje road, which on the north is limited with kindergarten, and on the east side the Janiševac I street, while on the western side it is limited with the Church's land where the main accent is the very building, the St. Anthony’s church.
The access road to the Health Center runs through the park and around it where they later built parking spaces. In the middle of the park is a monument to the fallen soldiers of Homeland war and bust of ‘šokac and šokica’, a gift by sculptor Ivo Krajnović, which was placed in front area of the park. The park volume consists of developed park trees and the grass surface with a paved access roads leading to the central part of the park, to the monument.
By the process of inventory it was found that there are 54 trees in the park, dominated by deciduous species.
The following species are determined: ash tree (*Fraxinus excelsior*), horse chestnut (*Aesculus hipocastanum*), sycamore (*Platanus orientalis*), maple (*Acer campestre*) and lime (*Tilia cordata*) [5, 6]. Trees which are within the parking space (Fig.5) will eventually lose its vitality and will require their removal (Fig. 6.). Lawns need renovation operations due to insufficient maintenance measures.In the back of the park there are two evergreen specimens which do not have greater significance for the appearance of the park. Numerically the most frequent are sycamore and horse chestnut."Continuous use of the lawn, with inadequate measures causes the destruction of lawn." The most common cause of severe soil compaction is the lack of maintenance measures [7].
The paths are paved with concrete elements and near them there are benches and waste bins, which are irregularly arranged and do not function due to damage.
The park lighting was installed along the road edge, and the central part of the park is unlit making it unsafe and uninteresting zone in the evening.

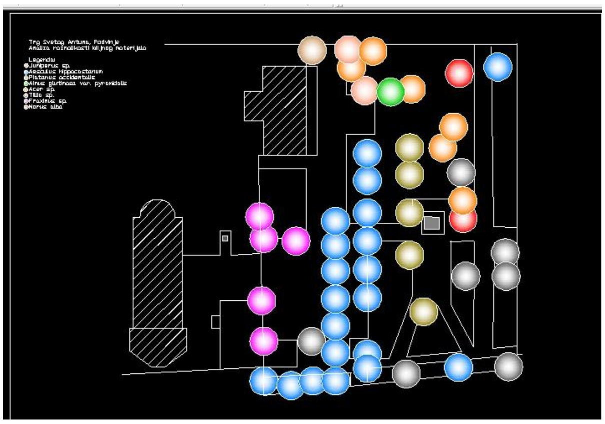

Figure 2. Park *floor* plan with the existing plant types

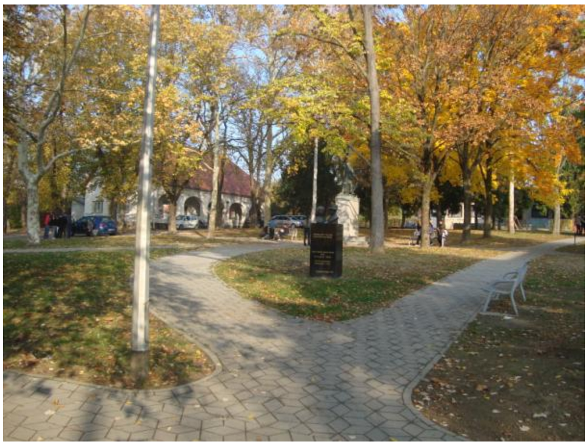

Figure 3. View of the monument and bust

Figure 4. Detail - bench *and waste bin*

Figure 5. View at the parking space

Figure 6. Detail – the irregular-planting

Table 1. Plant material inventory with the performed measurements

Code	Plant type	Stump diameter	Trunk diameter	Canopy diameter	Damage
1.	horse chestnut	310 cm	210 cm	11,0 m	None
2.	ash tree	103 cm	64 cm	6,5 m	Canopy
3.	ash tree	182 cm	143 cm	8,0 m	None
4.	ash tree	125 cm	96 cm	6,5 m	None
5.	ash tree	152 cm	120 cm	9,5 m	None
6.	horse chestnut	209 cm	151 cm	11,0 m	None
7.	ash tree	104 cm	85 cm	7,0 m	None
8.	horse chestnut	243 cm	170 cm	10,5 m	None
9.	lime	395 cm	229 cm	11,0 m	None
10.	horse chestnut	170 cm	120 cm	5,5 m	None
11.	horse chestnut	259 cm	156 cm	9,0 m	None
12.	horse chestnut	228 cm	147 cm	6,0 m	Branch
13.	horse chestnut	210 cm	159 cm	10,5 m	None
14.	horse chestnut	185 cm	173 cm	8,0 m	Branch
15.	horse chestnut	180 cm	142 cm	6,5 m	Canopy
16.	lime	398 cm	249 cm	13,0 m	Branch
17.	horse chestnut	166 cm	116 cm	5,5 m	None
18.	horse chestnut	243 cm	136 cm	8,0 m	Branch
19.	horse chestnut	207 cm	153 cm	9,5 m	Branch
20.	horse chestnut	226 cm	195 cm	9,5 m	Canopy
21.	horse chestnut	183 cm	151 cm	9,5 m	Branch
22.	horse chestnut	289 cm	180 cm	11,5 m	None
23.	lime	301 cm	205 cm	8,5 m	Canopy
24.	sycamore	230 cm	179 cm	16,0 m	Trunk
25.	sycamore	164 cm	122 cm	7,5 m	None

26.	sycamore	238 cm	171 cm	12,5 m	None
27.	horse chestnut	187 cm	114 cm	7,5 m	Trunk
28.	lime	221 cm	122 cm	9,5 m	Trunk
29.	suho stablo	-	-	-	None
30.	lime	280 cm	237 cm	13,5 m	Canopy
31.	lime	211 cm	194 cm	9,5 m	-
32.	lime	105 cm	201 cm	6,0 m	None
33.	horse chestnut	355 cm	201 cm	8,5 m	None
34.	maple tree	180 cm	142 cm	13,0 m	None
35.	lime	279 cm	148 cm	9,5 m	Trunk
36.	sycamore	195 cm	144 cm	11,0 m	Trunk
37.	maple tree	170 cm	139 cm	13,0 m	Trunk
38.	maple tree	169 cm	149 cm	10,5 m	None
39.	dry tree	-	-	-	Branch
40.	sycamore	152 cm	115 cm	7,0 m	None
41.	sycamore	213 cm	166 cm	10,0 m	-
42.	maple tree	181 cm	137 cm	11,0 m	Trunk
43.	horse chestnut	327 cm	201 cm	12,0 m	Canopy
44.	horse chestnut	220 cm	352 cm	12,0 m	None
45.	Juniper	134 cm	102 cm	6,5 m	Canopy
46.	Lombardy poplar	224 cm	188 cm	3,5 m	None
47.	maple tree	164 cm	162 cm	10,5 m	Branch
48.	maple tree	185 cm	170 cm	10,0 m	Canopy
49.	lime	211 cm	185 cm	8,0 m	None
50.	mulberry	188 cm	72+79 cm	9,5 m	None

4. Conclusion

The spatial analysis confirmed that the St. Anthony's square park is insufficiently maintained. The inventory showed that there are no particular rare plant species, but their ecological, aesthetic and sociological roles certainly have value. Since the park is situated near the church, health center and nursery it is providing protection from noise and pollution from traffic and provides a comfortable microclimate to its residents in the summer.
The high vegetation should be sanitary and safety pruned. Waste bins were destroyed, and the benches necessarily need technical protection measures. Furthermore, with the bench must be placed bare heights.

Since the Park is located in the center of the village Podvinje, as the only public urban green space it deserves attention and adequate maintenance for its social, environmental and aesthetic values.

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MANAGEMENT SECTION

SUPPORTING INNOVATIONS IN SMALL AND MEDIUM ENTERPRISES SECTOR IN SLOVAKIA

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Abstract
To strenghten innovation activities is one of the main task of small and medium enterprises (SMEs) nowadays. It´s also one of the priorities formulated in the strategy of building knowledged based economy in our country. The aim of the article is to give the view on the problems of developing innovation activities in SMEs sector in Slovakia. The article is divided into two parts. In the first part is given analysis of innovation activities in small and medium enterprises in Slovakia and main barriers to develop innovation activities in SMEs sector are identified. In the second part of the article attention is given to the problems of supporting innovation in SMEs sector. Strategic objectives and main priorities to support innovation activities in SMEs which are formulated in the Innovation Policy of the Slovak Republik for the 2011-2013 are presented. The paper is elaborated as a part of VEGA project 1/0654/11 “Innovative small and medium enterprises as a part of knowledge based economy in the Slovak Republik”.

Keywords:
small and medium enterprises, innovations, priorities, innovation policy, Slovak Republik

1. Introduction

The global business environment is changing very quickly. To the most important changes in the business sector belong trade liberalization and movement of financial capital, information and communication technological processes, changes in international division of labour and international trade, a huge concentration of capital connected with qualitative and quantitative changes in the size as well as in a character of enterprises. Strategic answer to all challenges resulting from changes in global business environment can be only development of economy based on innovations, knowledges and educated people [1].
Present approach to innovations prefers that innovation is a key word for entrepreneur; emphases global approach to innovations as a philosophy (way of managing of enterprises), which influences all parts of transformation process in enterprise (marketing, research and development, planning, manufacturing, managing, etc.) [2]. The ability to compete in innovations plays very important role as a factor of their competitiveness.

2. Innovation activities in Slovak small and medium enterprises

There exist no doubts about the benefits of innovations in all businesses. With the development of innovation processes in all types of enterprises, it is evident the growing role of innovations also in small and medium enterprises. Many examples confirm, that small and medium enterprises create a larger space for innovation, because they are much more flexible in comparison to large-scale enterprises. In spite of all above mentioned advantages, small and medium enterprises have also some handicaps – many of them don´t own research capacities and face many financial problems [3].
Between the size of enterprises and their innovation activities is a high correlation. In large enterprises is the proportion of innovation activities higher according to small ones [4].

Table 1 . Share of enterprises with innovation activity in total number of enterprises by their size in Slovakia (in %) – indicator 1

Indicator 1	2003	2004	2006	2008
All enterprises	19,4	21,1	22,7	33,6
Small enterprises	14,6	14,9	17,4	29,3
Medium enterprises	24,2	32,7	31,8	46,6
Large enterprises	47,5	57,4	56,6	67,9

Source: Statistical Yearbook of the SR, 2010

The increased share of enterprises with innovation activities in total number of enterprises is viewed positive – from 19,4 % in the year 2003 up to 33,6 % in the year 2008. It is evident, that the share of enterprises with innovation activity in small and medium enterprises has increased from the year 2003 up to 2008 two times. Thought the increase is viewed positive, there are still many barriers in SMEs sector (the barriers will be indicated later on).
Important indicator giving the view on innovation activities by type of innovation is share of enterprises with innovation activity in total number of enterprises by type of innovations in Slovakia (table 2).

Table 2 . Share of enterprises with innovation activity in total number of enterprises by type of innovation in Slovakia (in %) – indicator 2

Indicator 2	2003	2004	2006	2008
All kind of innovations *	19,4	21,1	22,7	33,6
Technological innovations	19,4	21,1	22,7	19,9
Product innovation only	11,9	3,7	5,0	3,8
Process innovation only	1,5	7,1	8,1	6,5
Product and process innovation		9,2	8,6	8,6
Ongoing or abandoned innovation activities only	5,1	1,1	1,0	1,0
Non-technological innovations	0,9	10,3	15,1	13,7
Without innovation activity	80,6	78,9	77,3	66,4

* Non-technological innovations were not included into innovation activity up to the year 2006
Source: Statistical Yearbook of the SR, 2010

Growth in number of enterprises implementing the processes innovations is viewed positive. While product innovations enable to reach the competitive advantage through changes in the product/services which an enterprise offers, processes innovations have the tendency to rationalize the production through changes in the ways in which product/services are created and delivered.
In the year 2009 was conducted at our faculty research oriented on the state of innovation activities in small and medium enterprises in Slovakia as well as on identification of main barriers to develop innovation activities in SMEs. Results of the research confirm, that 39 % of surveyed SMEs with innovation activities have improved technology of production, 17 % of SMEs have developed and implement quite new product (mostly from industry production) and 33 % of SMEs have innovated their product/service. SMEs have identified as the most important contribution from implementation of innovation activities: raise of turnover (70 %), lower costs of production (41 %) and raise of exports (15 %) [5].
Main barriers identified by small and medium enterprises to develop innovation activities are [6]:

1. Small and medium enterprises in Slovakia give as the main barrier to develop innovation activities lack of financial sources. The results of above mentioned survey confirm, that most of innovation activities were financed by their own financial sources. Law utilization of other financial sources is in many cases the consequence of a week informativeness about other alternative sources of finance. Various loan guarantee schemes for small and medium enterprises, schemes to support the start-up enterprises, venture capital, but also various EU programmes (especially initiative JEREMIE) could help as a source of finance. To fulfil the aim – to improve innovation activities by small and medium enterprises – it requires to be more active in the process of drawing financial means from EU funds.
2. Law awareness about the impact of innovations on their competitiveness was identified as a factor of unsufficient innovativeness in small and medium enterprises. This fact involves fear that small and medium enterprises don´t perceive innovations as a competitive advantage. In other words: it´s necessary to develop the innovation awareness in Slovak small and medium enterprises; attention has to be given to human resources for innovation.
3. Small and medium enterprises have identified as one of the barrier for innovation the lack of innovation infrastructure. Only a small part of small and medium enterprises posseses sufficient capacities as well as know-how for realization of all activities of innovative process, therefore it is needed to fill this gap with services of specialised consulting organisations. The aim is to create effective system of specialized consulting services for support of innovations. It´s also helpful to complete and extend existing infrastructure for support of innovations to the same level of leading european countries. It contains mainly technological incubators, technological and innovation centres and scientific parks. And important is also support of existing network of supporting organisations such as RPIC (Regional Business Innovation Centre), BIC (Business Innovation Centre), CPK (Centre of first contact) and others.
4. Positive examples from EU countries confirm, that the participation of small and medium enterprises in networks and clusters, support of partnership´s building is the way, how to involve small and medium enterprises into innovation activities. Innovation process of a higher level calls for improvement of interaction between small and medium enterprises, research institutions and universities and for creation of various effective networks and partnerships. Many positive example in Slovakia (from commerce, services, automobile industry, machinery industry, wood industry) confirm the advantages of this progressive form of organization.

5. Example of how to use the opportunities which offers globalization for small and medium enterprises (especially in countries with small internal market) represent firms born global (global start-up firms) [7]. They play an important role in the development of innovation. Born global firms are becoming the driving power of radical innovations in the new economy [8]. They create new markets for new products.

It can be stated, that a systematic approach to innovation activities in small and medium enterprises calls for [9]:

- generating ideas and permanent accumulation of all impulses which could lead to innovations,
- creative human resources,
- ability to judge the reality of innovation ideas,
- effective team work,
- ability to manage innovation projects,
- cooperation with external institutions (universities, research institutes, consullting agencies),
- ability to judge the risk,
- ability to posses the right courage and spirit,
- motivating all workers,
- implementing systematic education.

In today´s entrepreneurial practice innovations must be natural part of any entrepreneurship. Permanent and regular innovation is becoming a competitive necessity; to be successful in the future requires interrupting conventions. There is a time of changes and the only way how enterprise can be successful is to accept these changes, adapt to them and utilize them.

3. Supporting innovations in small and medium enterprises – main priorities of Innovation policy of the Slovak Republic for 2011-2013

Strategic objectives of making innovation one of the main instruments in developing the knowledge economy, ensuring high economic growth of the Slovak Republic and catching up with the most advanced EU economics, are included into the "Innovation Strategy of the Slovak Republic until 2013" and the "Innovation Policy of the Slovak Republic for 2011-2013" [10], [11]. The Innovation Policy reflects the OECD recommendations listed in the Overview of the Economic Survey of the Slovak Republic of 2010, in particular from the long-term structural viewpoint.

The Innovation Policy of the Slovak Republic for 2011-2013 is reflecting and aimed at three most important priorities.

The *first priority* is oriented on development of high-quality infrastructure and an efficient system for innovation development. Besides others as one of the main measures was indicated support to innovative industrial cluster organisations in Slovakia. It is pertaining to some selected activities – that are more likely to stimulate competitiveness – rather than targeting the whole gamut of industrial activities. The purpose of this measure is to improve industrial competitiveness through support to selected activities of industrial cluster organisations, with a view to promoting joint industrial activities in selected areas. The measure could help in supporting selected cluster activities which contribute to increasing the competitiveness of the innovative cluster organisation´s member companies

While facilitating the development of clusters, the creation of a supporting development instrument will mainly contribute to increasing the innovation capacity of the companies that are members of the cluster organisations. The measure will thus indirectly stimulate the development of small and medium enterprises, which are the ones most vulnerable in the long-term – also due to their lack of innovation capabilities, as well as to stimulate the establishment of new cluster organisations, thus stimulating cooperation in diverse industries or regions. Positive is viewed, that this measure will favour cluster organisations which focus on high-tech, those which operate in less developed regions, and internationally recognized cluster organisations.

As the *second priority* was indicated "High-quality human resources". Of special importance is the measure oriented on "Innovation education for small and medium enterprises". The objective of this measure is to provide education and training to firms and entrepreneurs in the area of innovation activities. The reason for the adoption of this measure is a low level of innovation activities and creativity of businesses with small and medium enterprises falling within the category of low innovative organisations, in particular. A series of special training courses on innovative activities and special practices and procedures will be organised under this measure. Educational activities will be carried out in cooperation with cluster organisations, industrial chambers and associations operating in Slovakia, as well as with higher territorial units and municipalities.

The measure "Lifelong learning and counselling system" is a respond to the strategic objective to introduce an effective, ethic-based system of further training and career counselling, facilitating citizens access to flexible possibilities to extend and deepen their qualification in order to improve their chances on the labour market and encouraging their personality development and a better quality of life.

The special measure "Secondary vocational education" has as an objective to ensure qualified and skilled labour with a particular emphasis on the development of small and medium enterprises and major investors in Slovakia; ensuring a sufficient number, structure and quality of secondary vocational school graduates to meet the demands on the labour market.

The *third priority* is oriented on "Development of efficient tools for innovation". The first measure in this priority is oriented on elaborating of national incentive project to enhance Slovakia´s innovation. The lack of funds combined with the lack of innovation incentives are major problems in Slovakia.

The special measure is oriented on "Support of innovation activities in enterprises". The purpose of this measure is to increase the competitiveness of industry through supporting R&D based innovation activities by businesses, by supporting the introduction of new innovation technologies (not their purchase), procedures, or products. The measure is a follow-up to a measure implemented under the 2008-2010 Innovation Policy.

Lack of financial sources is viewed as one of the main barriers to develop innovation activities by enterprises. The aim of the measure "Financial engineering instruments – innovation funding support and support to increase public spending on innovation" is to mobilise financial resources in the area of innovation support in order to ensure that innovation activities performed by business entities receive the same level of funding as those in advanced EU countries. In connection with efforts towards the most effective use of allocated financial resources, an indirect state aid will be provided to profit-generating projects implemented by SMEs, i.e. financial engineering instruments such as guarantee funds, credit funds, venture capital funds and municipal development funds.

A new limited company, Slovenský záručný a rozvojový fond, s.r.o. (Slovak Guarantee and Development Fund) was established in 2009. The company, together with the European Investment Fund, runs a holding fund by means of which financial engineering instruments will be implemented in Slovakia under the JEREMIE initiative. The goal of the JEREMIE initiative and of the repayable aid provided in the form of innovative financial instruments is to support small and medium enterprises. It is estimated that financial support in the form of bank guarantees, indirect loans and venture capital may be provided to some 400-600 entities. These entities should primarily include small innovative companies with strong growth prospects which have problems to fund their expansion and innovation activities.

4. Conclusion

Today more than ever, economic growth and progress requires the promotion of innovation and the development of proper tools to that end. Support must target the areas of efficient system for innovation development, high-quality human resources and efficient tools for innovation. All these areas represent the main priorities of the innovation policy of the Slovak Republic for 2011-2013.

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RESIDENTIAL SAVINGS EXPERIENCES IN CROATIAN BANKS

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Abstract
The authors analyze residential savings on the examples of three building societies. The aim of this paper is to describe the banking business through the creation and development of banking and through their division based on the analysis of selected housing savings deposits. In other words, to check and identify the strengths and weaknesses in selected societies. Furthermore, there are analysis of the amounts of payments, savings, government incentives, interest rates and contract fees.

Keywords:
banking, savings, building societies, interest rate loan.

1. Introduction

The science of banking is the discipline that scientifically explains the special influence of monetary factors and monetary transactions. Banking is engaged in researching the role, meaning and operation of banks as major financial institutions and economic systems of the country. It is tasked to investigate and monitor general economic trends and the functioning of banks in the banking system. It is,also, studying the function and role of the banking system, banking, and especially relationships, processes and business transactions that occur based on the creation and use of money through banks.

2 . The banking system in Croatia

The Croatian banking market has currently operating 32 banks, 2 savings banks, the Croatian Bank for Reconstruction and Development, and 5 savings banks. Their representative offices in Croatia has 5 foreign banks. "The share of the banking sector in the total assets of financial institutions at the end of year, 2011. was 66.4 percent. The reserve requirement rate is 13.5 percent. "[1] The basis for the calculation of the reserve consists of domestic and foreign currency. The discount (discount) rate of the CNB is 9 percent per year. The share of foreign ownership in total bank assets in year, 2011 was 90.6 percent. There were 17 foreign-owned banks, 13 banks in domestic private ownership, and 2 banks are state owned. According to the data in Table 1, it is possible to observe the trend movement in the number of banks and savings banks in the Republic of Croatia in the period since 2009 to year 2011.

Table 1. Number of banks and savings banks in the Republic of Croatia in the period since 2009 to 2011. [1]

YEAR	NUMBER OF BANKS	NUMBER OF SAVINGS BANKS
2009.	36	2
2010.	36	2
2011.	32	5

In Table 1. we can observe the fall in the number of banks, and the increase number of savings banks.

"The diversity bank types has its origin in the basic banking functions, and they are:

- Currency transaction
- The receiving of deposits and transfers
- The lending

Other banking functions (based on the primary) are:

- The nature of credit and guarantees
- The transfer
- The issuance of securities "[2]

For these banking functions there are three fundamental divisions derived of banking operations in accordance with the following principles:

- The principle of functionality
- The principle of deposits
- Balance-analytical principle

According to the principle of functionality banking transactions vary according to economic function of the banking business. We distinguish: mobilization activities, the concentration of resources, credit operations, intermediate-managed funds and their own affairs. By the criterion of deposits, the banking operations are divided into short and long term. "Balance analytical criterion for the division of banking is very convenient due to globalization and internationalization of banking activities and their monitoring. The basic criterion for distinguishing these operations is the role of banks in a particular job. "[3]

Balance sheet of banking transactions according to analytical criteria are:

1. Active banking jobs - jobs in which the bank emerges as a lender and borrower, and a lender as a borrower from whom bank charges interest.

2. Passive banking jobs - jobs in which the bank emerges as borrower, or by performing these operations the bank collects the funds needed for its work.

3. Neutral banking operations - are also called intermediate transactions, a bank performs it for a commission or other contractual services. The neutral banking business includes brokerage payments, conservation and management of securities, buying and selling securities, the exercise of credentials and issuance letters.

4. Private banking operations - Treasury banking transactions performed by banks in their own name and for its own account in order to make profit. These are the most recent jobs, resulting in the development of markets and market economies, and globalization in general.

5. Administrative-control banking jobs - supervision and control, work for the purposes of bank administration. They are mostly performed by the central bank, and are related to the execution of state budget.

In Table 2. are shown banks classified by size of bank balance sheet assets.

Table 2. Banks are classified by size of balance sheet assets [1]

ASSETS	2009.	2010.	2011.
Less than 100 mil. HRK	3	3	4
From 100 till less than 500 mil. HRK	6	5	4
From 500 mil. till less than 1 mlrd. HRK	2	2	2
From 1 till less than 2 mlrd. HRK	10	11	8
From 2 till less than 10 mlrd. HRK	7	7	7
10 and more mlrd. HRK	8	8	8

According to data from Table 2 it can be noted that in the Croatian banking system the most banks assets range from 1 to less than 2 billion HRK.

Furthermore, we have Table 3 which shows the savings banks classified by size of balance sheet assets.

Table 3. Savings banks classified by size of balance sheet assets [1]

ASSETS	2009.	2010.	2011.
Less than 100mil. HRK	1	1	1
From 10 till less than 100 mil. HRK	1	1	1
100 and more mil. HRK	0	0	3

The total assets of housing savings banks is 1.8% of total banking sector assets. The assets of housing savings banks at the end of June 2010. totaled 6.39 million HRK, which is 200 million less than at the end of June 2009., a decline in assets compared to June last year had PBZ's, First Housing and Raiffeisen building society.

3. Comparative analysis of housing savings on the example of these three building societies

A building society may establish a bank pursuant by the Act on Credit Institutions. "Approval for the establishment and operation of building societies, on the basis of a written request is issued by the Croatian National Bank with the prior approval of the Ministry of Finance." [1]
The authors analyzed housing savings on the examples of Raiffeisen savings banks, building societies of Croatian postal bank and building societies of Privredna bank Zagreb.
The analysis of building society are based on the following hypotheses:

1. The hypothesis H1: There are significant differences in the supply of housing savings in building societies.

2. Hypothesis H2: There are significant differences in the partnership bank to customers in return for contracts on Building Societies.

3. Hypothesis H3: There are significant differences in the deposits of loans in building societies

In Table 4 we can see varieties of housing savings in selected building societies.

Table 4 Types of housing savings in selected societies [6] [7] [8]

Residential savings	RBA		HPB	PBZ
1	Family	Funky	Mini savings	Prima savings
2	Kvaka-štednja	Jazz	Maxi savings	Base savings
3	Bubašpara	Impuls	Multi savings	Golden savings
4		Relax	Child Multi	Children Golden

"When choosing a type of savings and by closing the Contract on Building Societies agreed amound is arranged. It consists of the amount of savings funds (which are expressed as the sum of all deposit payments) of state incentives and interest on the deposit (savings after payment of collection fees) and interest paid on government incentives and housing loans. The amount of housing loans is a difference between the contracted amount and savings. "[5] The minimum amount for the agreed amounts is in HRK equivalent of 2,000.00, € while the maximum height stipulated amount is in HRK equivalent 200,000.00 €.

In Table 5. calculation is followed for housing savings in all three building societies, if the contractual amounts are equal and amount to 3,300.00 €

Table 5. Notional amount in selected societies [6] [7] [8]

DESCRIPTION	HPB	PBZ	RBA
Notional amount	3.300,00	3.300,00	3.300,00
Deposit	37,26	40,00	39,00
Paid amount	894,22	960,00	936,00
DPS+ Interest	136,97	157,41	164,21
Savings	990,00	1006,00	1084,80
Profit	95,81	117,75	148,80
EIR savings	9,81%	11,12%	10,58%
Credit	2310,00	2294,00	2284,32
Annuity	19,12%	29,91%	16,00%
EIR credit	3,12%	5,50%	6,27%

Based on data in the table it is possible to conclude that the Raiffeisen building society gives the highest interests and DPS, and by saving in the Raiffeisen building society customers achieve the maximum profits. PBZ has the best building society EIR (effective interest rate) on savings, while HPB building society offers the best APR on the loan.

The movement of interest rate in the analyzed building societies is shown in Table 6

Table 6 Interest rates on savings and credit societies analyzed. [6] [7] [8]

Residential savings	TARIFF	INTEREST RATE-SAVINGS	INTEREST RATE-CREDIT	MIN. SAVING TIME
RBA	Funky	2,50%	5,50%	2
	Jazz	3,00%	6,00%	5
	Impulse	2,50%	5,50%	2
	Relax	3,00%	5,99%	5
HPB	Mini	1,00%	3,00%	2
	Maxi	2,00%	4,00%	5
	Multi	3,20%	4,80%	5
	Child Multi	do 3,60%	4,80%	5
PBZ	Prima	2,00%	4,88%	2
	Base	2,00%	4,88%	5
	Golden	3,10%	5,44%	5
	Children Golden	3,1-3,5%	5,44%	5

In accordance with the interest rates it is possible to conclude that the HPB Mini has the lowest rate of savings, while HPB Multi child has the highest interest rate savings. HPB Mini residential savings has the lowest interest rate on the loan, while the RBA Jazz has the highest tariff rate on the loan. In HPB's most effective is Children's Multi Housing savings because the interest rate on savings is 3.6%, while the interest rate on the loan is 4.80%.

By its savings business principles residential savings require to pay a certain amount, and savings in a period of time in order to be entitled to apply for credit. (Table 7.)

Table 7. Amount of savings needed to be entitled to credit [6] [7] [8]

Residential savings	Part of savings in %	Tarifa
RBA	30	Funky
	40	Jazz
	30	Impulse
	40	Relax
HPB	30	Mini
	40	Maxi
	40	Multi
	40	Child Multi
PBZ	30	Prima
	40	Base
	40	Golden
	40	Children Golden

When choosing a type of savings and by closing the Contract on Building Societies agreed amound is arranged, and the smallest proportion of savings should be 30% of the total amount of savings and the time period of at least two years. From the table it can be seen that for raising 30,000 € we have to had saved 9,000 € (if necessary 30%).

Residential savings required to pay back loans within a certain period of time. Repayment of loans is shown in Table 8.

Table 8. The maximum number of years in repayment for all of these savings rate [6] [7] [8]

Residential savings	Repayment of loans in years	Tarifa
RBA	8	Funky
	15	Jazz
	20	Impulse
	20	Relax
HPB	12	Mini
	18	Maxi
	20	Multi
	20	Child Multi
PBZ	20	Prima
	21	Base
	20	Golden
	21	Children Golden

Repayment of loans range from 8 to 21 years, the longest repayment period can be achieved with PBZ building society in the Bazna and the Golden children's savings.

4. Conclusion
Based on the analysis, the authors concluded that there are:

1. significant differences in the supply of housing savings in selected societies,

2. significant differences in the partnership from banks to customers with contract fees of Residential savings,

3. significant differences in the repayment of loans in analyzed residential savings, which has been proven through conducted research.

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POSSIBILITY OF USING PUBLIC-PRIVATE PARTNERSHIPS TO IMPROVE THE ENERGY EFFICIENCY OF PUBLIC BUILDINGS IN THE REPUBLIC OF CROATIA

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Abstract
According to numerous studies the energy efficiency of public buildings in the Republic of Croatia (schools, colleges, hospitals, government, etc) is extremely low (in relation to the European average), which is best seen from the energy required for heating and cooling. With a moderate investment in improving the energy efficiency of public buildings could be achieved large savings in energy expenditures on an annual basis. However the public sector due to the current economic situation does not have sufficient funds for necessary investments, and therefore imposed public-private partnerships as one of the solutions. This paper explores the possibility of the use of public-private partnerships to improve the energy efficiency of public buildings in the Republic of Croatia.

Keywords:
Public Sector; Public Private Partnership; Energetic Efficiency; Public Buildings

1. Introduction

Given the constant increase in energy prices over the last few decades (particularly expressed through the increase in oil prices), and heightened environmental awareness of people turning to alternative energy sources is a current trend. But the quickest and cheapest way to reduce energy costs and reduce emissions into the environment certainly has improved the energy efficiency of new buildings (both public and private), primarily through the use of better materials in the construction process. With energy-efficient construction of new buildings is a lot of attention given to improving the energy efficiency of existing buildings through increased investment in insulation (renewal of windows and doors, change the facade, installation of insulation in roofs, etc.). According to numerous studies the energy efficiency of public buildings in the Republic of Croatia (schools, colleges, hospitals, government, etc) is extremely low (in relation to the European average), which is best seen from the energy required for heating and cooling. With a moderate investment in improving the energy efficiency of public buildings could be achieved large savings in energy expenditures on an annual basis. Precisely because of these savings and extremely fast results improve the energy efficiency of public buildings is set as one of the priorities of the new Croatian government. With these energy saving plan to improve energy efficiency and achieves other important economic goals. This primarily refers to the "awakening" of a "sleepy" Croatian construction sector and the employment of its operations and a number of construction workers.
However the public sector due to the current economic situation does not have sufficient funds for necessary investments, and therefore is imposed public-private partnerships as one of the solutions. This paper explores the possibility of the use of public-private partnerships to improve the energy efficiency of public buildings in the Republic of Croatia. The paper is structured in several a chapter in the first of which is defined by the concept of private partnerships and its forms. The following chapter shows the basic advantages and disadvantages of public-private partnership model and the current situation of energy efficiency of public buildings in the Republic of Croatia. In the next chapter explored the possibility of applying the model of public-private partnerships to improve energy efficiency. The conclusion brings a synthesis of research in the literature sources used are listed in the paper.

2. What is Public Private Partnership?

There is no single, internationally accepted definition of “Public-Private Partnership” and in broad view of PPP, it could be defined a long-term contract between a private party and a government agency, for providing a public asset or service, in which the private party bears significant risk and management responsibility [1]**.** Public-Private Partnerships (PPPs) aim at financing, designing, implementing and operating public sector facilities and services. Their key characteristics include [2]:

- Long-term (sometimes up to 30 years) service provisions;
- The transfer of risk to the private sector; and
- Different forms of long-term contracts drawn up between legal entities and public authorities.

There are significant differences between a conventional construction procurement project and a PPP project that need to be clearly understood. The main differences include [3]:

- PPP projects are different from conventional construction projects in terms of project development, implementation, and management.
- A PPP project is viable essentially when a robust business model can be developed.
- The focus of a PPP project should not be on delivering a particular class/type of assets but on delivering specified services at defined quantity and levels.
- The risk allocation between the partners is at the heart of any PPP contract design and is more complex than that of a conventional construction project.
- A PPP contract generally has a much longer tenure than a construction contract.

There are a range of PPP models that allocate responsibilities and risks between the public and private partners in different ways and following terms are commonly used to describe typical partnership agreements [4]:

- Buy-Build-Operate (BBO): Transfer of a public asset to a private or quasi-public entity usually under contract that the assets are to be upgraded and operated for a specified period of time. Public control is exercised through the contract at the time of transfer.
- Build-Own-Operate (BOO): The private sector finances, builds, owns and operates a facility or service in perpetuity. The public constraints are stated in the original agreement and through on-going regulatory authority.
- Build-Own-Operate-Transfer (BOOT): A private entity receives a franchise to finance, design, build and operate a facility (and to charge user fees) for a specified period, after which ownership is transferred back to the public sector.
- Build-Operate-Transfer (BOT): The private sector designs, finances and constructs a new facility under a long-term Concession contract, and operates the facility during the term of the Concession after which ownership is transferred back to the public sector if not already transferred upon completion of the facility.
- Build-Lease-Operate-Transfer (BLOT): A private entity receives a franchise to finance, design, build and operate a leased facility for the lease period, against payment of a rent.
- Design-Build-Finance-Operate (DBFO): The private sector designs, finances and constructs a new facility under a long-term lease, and operates the facility during the term of the lease.
- Finance Only: A private entity, usually a financial services company, funds a project directly or uses various mechanisms such as a long-term lease or bond issue.
- Operation & Maintenance Contract (O & M): A private operator, under contract, operates a publicly owned asset for a specified term. Ownership of the asset remains with the public entity.
- Design-Build (DB): The private sector designs and builds infrastructure to meet public sector performance specifications, often for a fixed price, turnkey basis, so the risk of cost overruns is transferred to the private sector.
- Operation License: A private operator receives a license or rights to operate a public service, usually for a specified term. This is often used in IT projects.

3. Advantages and disadvantages of Public Private Partnership models

Public Private partnership can provide a number of specific benefits to the public [5]:

- Better value: The decision by government to pursue PPP delivery is often based on analysis to determine that the PPP approach will deliver value to the public through one or more of the following: Lower cost; Higher levels of service; and Reduced risk
- Access to capital: PPPs allow governments to access alternative private sources of capital, allowing important and urgent projects to proceed when otherwise they may not be possible.
- Certainty of outcomes: Certainty of outcomes are increased both in terms of 'on time' delivery of projects (the private partner is strongly motivated to complete the project as early as possible to control its costs and so that the payment stream can commence) and in terms of 'on-budget' delivery of projects (the payment scheduled is fixed before construction commences, protecting the public from exposure to cost overruns).
- Off balance sheet borrowing: Debt financing that is not shown on the face of the balance sheet is called 'off balance sheet financing'.
- Innovation: By combining the unique motivations and skills of both the public and private sectors and through a competitive process for contract award, there is a high potential for innovative approaches to public infrastructure delivery with PPPs.

The biggest criticism, the partnership obtained by the traditional public administration for fear of weakening political control in the decision process.

Similarly, the unions are against the PPP for fear of losing jobs and poor working conditions, as well as citizens and end-users of services because they fear that the main motive could only be a profit.
There are many important economic, social, political, legal, and administrative aspects, which need to be carefully assessed before approvals of PPPs are considered by the government. PPPs have various limitations which should also be taken into account while they are being considered. The major limitations include [6]:

- Not all projects are feasible (for various reasons: political, legal, commercial viability, etc.).
- The private sector may not take interest in a project due to perceived high risks or may lack technical, financial or managerial capacity to implement the project.
- A PPP project may be more costly unless additional costs (due to higher transaction and financing costs) can be off-set through efficiency gains.
- Change in operation and management control of an infrastructure asset through a PPP may not be sufficient to improve its economic performance unless other necessary conditions are met. These conditions may include appropriate sector and market reform, and change in operational and management practices of infrastructure operation.

4. PPP and improvement of energy efficiency of public buildings in Croatia

Energy efficiency has been recognized worldwide as the most efficient and cost effective way of achieving sustainable development goals: reducing negative impacts on the environment, which produces the energy sector, reducing carbon emissions, increasing security of energy supply interruption correlation between economic growth and increasing demand for energy, but also the contribution increasing the competitiveness of national economies and therefore to energy efficiency should play a key role in the overall national energy policy [7]. Total primary energy consumption in Croatia by 20.1% and gross energy intensity by 19.3% higher than the average EU-15 states as a burden for the national economy and the environment. It is estimated to lose about 1% of gross national product for a low energy efficiency [8]. Improving the efficiency of energy consumption helps in achieving the goals of sustainable development, especially in the environment due to reduced emissions of harmful gases into the atmosphere, and then in improving the economic stability by increasing the competitiveness of industrial production, reducing dependence on imported energy and job creation [9]. In public budgets in the Republic of Croatia (state, counties, cities and municipalities) is a significant expenditure of energy consumption (natural gas, heating oil, firewood, electricity) and water that are intended to cover expenses for the regular needs and expenditures for the current maintenance of buildings and equipment in public institutions or public buildings and facilities owned by state and local (regional) government (schools, kindergartens, sports facilities, facilities in the area of culture, social welfare, health care, infrastructure and other facilities) or in enterprises, public institutions or public buildings and facilities operated by or financed in part from its state budget and local and district (regional) governments [10]. According to available statistical data Buildings are the largest single consumers of energy and an important source of emissions (especially CO2) [11]:

- 2010th the final energy consumption in buildings was 42.3% of total energy consumption in Republic of Croatia
- Energy in buildings used for: (a) heating and hot water - 80 -90% of total energy needs of the building; (b) lighting and other purposes (eg PCs) - 10 - 20% of total energy consumption and (c) cooling has a minor part of total annual energy consumption, but the expected steady growth in energy consumption in this sector

Croatia per unit of product consumes two times more energy than the EU standards, while imports over 50 percent of energy, and the largest portion of losses, 48 percent in buildings, and 80 percent of buildings unnecessarily loses 60 percent of energy [12]. Precisely because of these devastating data Croatian Government adopted the 2012th Energy renewal program of public buildings 2012-13. that the basic aims of investments in the promotion of energy efficiency of public buildings. With the stated primary objective, is clearly stated the aim of creating new jobs, especially in the construction industry. Above mentioned program provides for the implementation of projects contracting a form of public-private partnerships. The contractual form of public-private partnership has been recognized as a model that allows much faster implementation of such a large and demanding program, and as a model by which the Republic of Croatia, can create the necessary conditions for successful implementation of programs in the field of science, education, education, health, justice, culture, social welfare and defense in the short to medium term, particularly if one bears in mind that the present method for investments in public buildings resulted in uneven standards, uneven quality and cost of construction [13].

5. Conclusion

One of the main tasks of each country is concern about the quality of life for its citizens, which outlines the provision of certain public goods like roads, hospitals or schools. Quality assurance of these goods requires large financial resources which the state does not have at all times, and as an excellent solution to this problem appears in public-private partnership that is a concept already well known in developed countries. Under this concept it is a partnership of public sector or the government and the private sector to finance various projects of public interest in a manner more effective than traditional service delivery by public sector. On the other hand, each state must rationally relate to the state budget and take care of minimizing unnecessary costs. Due to the increased cost of energy has been increasingly recognized that many savings can be achieved in improving the energy efficiency of public buildings through investment in a new facade, windows and roof insulation. Strong expansion of public-private partnerships in the last twenty years in the world has not bypassed the area of energy efficiency where it can extract many forms of partnership and executed numerous projects. Therefore, since the budgets in Croatia is limited due to the economic crisis as an excellent model of energy efficiency improvements imposed by the public-private partnership that has many advantages and some disadvantages. Although the Croatian experience is still clearly insufficient to model of public private partnership can bring double-benefit: saving the budget through lower costs for energy and stimulation, "sleepy" construction sector. In addition, in each case of public-private partnerships commitment to the partnership must be proved by analyzing the costs and benefits. Public-private partnerships cannot solve all the problems the public sector but it can significantly improve the availability, quality, innovation and price of public services.

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SAFETY DATA FLOW BY DIGITAL SIGNATURE WITHIN LEGAL REGULATIONS

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Abstract
The goal of this study was to determine and explain the application of digital signatures within the system of public keys. The basics of ICT (Information and Communications Technology) security are defined, and an overview of the basic methods of cryptography and hash functions has been given. Furthermore, the terms of electronic and digital signatures are explained as well as public key infrastructures. Also, the institutions related to computer security and the issuance of digital certificates is described and digital signatures legal basis application.

Keywords:
Security, Digital signature, Legislation

1. Introduction

Since the beginning of human literacy, until now, generally accepted way of documents verification was a handwritten signature. One can find signature, now days, on a number of documents, securities, contracts, and private letters and by the relevant legislation it is considered to be a certificate of authenticity and credibility. However, in the domain of computers and electronic business, the signature does not have this feature. For the purposes of the safe operation it was necessary to develop its electronic equivalent.
The security of electronic business in the first place assumes knowledge of certain rules and norms of behavior by users, the characteristics of the computer and the user's computer system, and finally, methods and systems of protection in the process of data exchange.
The main role here takes cryptography. By using the methods of discrete mathematics, and combined with the principles of computer systems it will provide the foundation for secure electronic commerce - a digital signature.

2. Computer security

Computer security is a basic prerequisite for working on your computer. Computer security is based on: confidentiality, integrity and availability.
Confidentiality presents a system protection against unauthorized access. Data must be protected and available only to those persons who have access to this data. In the following two things are important: user identification and authentication.
Integrity - refers to the integrity and completeness of data within the system.
Availability - the system must ensure data availability to all its authorized users at any time, or when the information is required. Figure 1 shows the relationship between components of computer security.

Figure 1. The components of computer security [1]

Security is a process of maintaining an acceptable level of risk [2]. Principal steps in the computer safety are assessment, protection and detection. The steps are shown in Figure 2

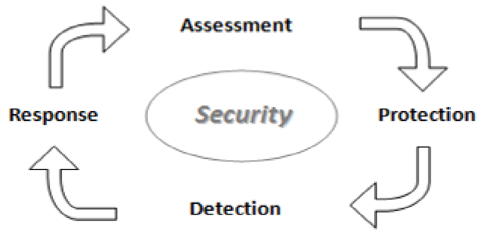

Figure 2. The security as a process [1]

3. Threats, attacks, vulnerabilities and risks

The reason for establishing the computer safety is the threats and attacks. The threat of a computer system can be each person, situation or set of circumstances that may cause its vulnerability, while the realization of an attack or threat is an action which endangers the safety of the system, network or information [3].
Threats can be passive (not directly affect the functioning and behavior of a computer system) and active (directly affecting the computer system and its normal operation).
Computer attacks are classified into four categories: Interruption (an attack on availability), Interception (attack focused on confidentiality), Modification (active attack centered on integrity) and Fabrication (active attack on the confidentiality by misrepresentation of a user or a server). The categories of attacks are shown in Figure 3.

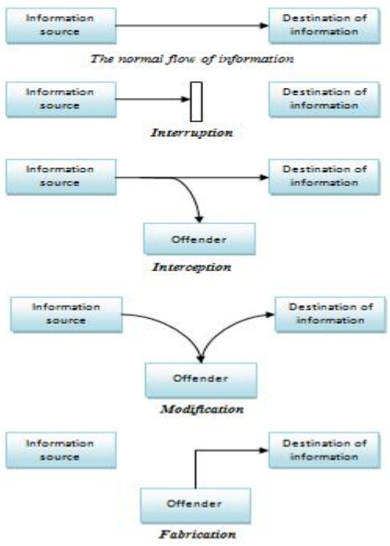

Figure 3. Categories of attacks on computer systems [1]

The consequence of threats and attacks are vulnerabilities and risks. Vulnerability represents a weakness in a resource value or assets that can be used, and is a consequence resulting in a poor design, implementation, or "pollution".
The risk is, in the context of computer systems security and networks, the danger measure, or the ability to create a damage or loss of information [3].
In determining the risk three groups of questions come to mind:
- What are the possible threats? What may happen, and what can be done about it?
- How often a threat can happen?
- How much damage can occur, how much will the damage repair cost, and whether is it cost effective?

The answers to these questions need to maintain a balance between the needs and opportunities for the application of certain security steps. Thus, some risks will be eliminated or reduced by safety measures, while we will have to accept some risks.
The ultimate goal of the process is to preserve the three main information security grounds: confidentiality, integrity and availability.

4. Safety and Protection Methods

Methods of computer and information systems protection are classified as: physical methods, organizational methods, software methods and cryptographic methods [1].
The basis of physical security is the protection of computer equipment, space in which it is located, storage media and communication equipment. It includes all measures taken to protect the computing infrastructure of environmental impacts, natural disasters, accidents and intentional damage. Organizational methods determine how organizations manage computing resources and security implementation, security management when accessing the resources of third parties, and where the responsibility for processing the data is submitted to the external user (outsourcing).
Protection program is implemented at three levels: the level of applications, operating system level, and the level of network infrastructure.
The protection level applications include: software applications protection, isolation of important applications on networked computers and servers, application of specific protocols. The operating system protection level includes the connection of the operating system - applications, as well as the relationship with the network architecture like links with other systems. According to some recommendations minimal protection include: blocking of unnecessary services, providing comprehensive and mandatory access control on user level, allowing the integrity of the program that makes the operating system. Protection at the network infrastructure assumes the application of network barriers, i.e. a firewall to block unnecessary connection ports, encoding paths, isolate routers and paths by commutates or with special infrastructure. Cryptographic methods are based on the protection of information and they are more detailed explained in the next chapter.

5. Cryptography

Cryptography is the scientific discipline, based on applied mathematics, which studies methods for sending in messages in that kind of form that can only be read by those who were they intended to [4]. The main task of cryptography is to enable two people to communicate over insecure communication channels in a way that a third person cannot understand their messages.
Conventional encryption or even known by the name of the encryption "symmetric key" uses one key for encryption and decryption.
The method of public key is an asymmetric scheme that uses a pair of keys for encryption:
- Public key: used to encrypt data
- The secret (private) key: used to decrypt

The asymmetric cryptosystems are based on certain properties of numbers that belong to the theory of numbers. The most widely used public key cryptosystem is the RSA cryptosystem (algorithm for public-key cryptography).
In the asymmetric cryptosystem an important role has the Hash function. The Hash one-way function is a function that converts the input of variable sizes into a line of specific characters with determined length.

6. The electronic signature

An electronic signature is a general term for the technology and method of performance that encompasses all the methods that can be used to sign electronic information [4].

These methods may be easier but unreliable, such as digitized copy of a handwritten signature, to the more complex and reliable methods like digital signature. In the Republic of Croatia by passing the law on electronic signature it was also defined an advanced electronic signature. The advanced electronic signature is an electronic signature that is associated exclusively with the signatory, clearly identifying the signatory, is created by using means with which the signatory can operate independently and are solely under the control of the signatory and contains direct links to data to which it relates in such a way that clearly allows access to any amendment to the original data [5].
Thus, the advanced electronic signature has the same legal force and replaces the handwritten signature or signature and seal. So, with the electronic signature and its formal legal validity Croatia is included in the global economic and market e-business processes.

7. A digital signature

The technology of digital signatures is using asymmetric encryption technique, combining it with the use of hash functions. The sender and receiver have the pair key of which one is secret, and other is one is all available public key. The keys are mathematical algorithms that are issued by the certification body. The basis of digital signature makes the content of the message.
PKI (Public Key Infrastructure) is a set of hardware, software, people, regulations and procedures necessary to create, maintain, and distribute certificate revocation based on public key cryptography. The system is based on a strict hierarchical organization of issuing user certificates. The process of digital signature is shown in Figure 4

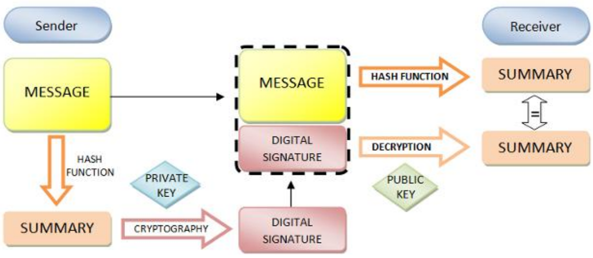

Figure 4. Digital message signature [1]

What a digital signature does not ensure is the confidentiality, since the message travels to the recipient in an unmodified form.
To meet the requirement of secrecy, the message can be further encrypted by using one of the cryptographic algorithms.

8. The institutions support and legal basis

The Institute for Information Systems Security (IISS) is the central body of the Croatian government for performing in the technical areas of information security in government agencies including standards for information security systems, security information systems accreditation, management of crypto material used in the exchange of classified information and coordination of prevention and responses to the computer threats to information security. One of the first tasks of IISS, on the basis of information security, is the standards regulation of information security systems with regulation rules that will apply to all state bodies, local and regional governments, legal persons with public authorities who in their jurisdiction use classified and unclassified data as well as legal and non-legal persons who have access to or handle classified information.
In addition to making regulation rules, IISS is also responsible for the continuous alignment of technical standards areas of information security systems in the Republic of Croatia with the international standards and recommendations and a participation in the national standardization of information security systems.
The legal framework for the Croatia's development in the information society is determined by a series of laws, regulations and ordinances. For the computer and information security, and security in electronic transactions, the most important are:
- The Information Security Act (NN 79/2007)
- The Secrecy Act (NN 79/2007)
- The Law on Electronic Commerce (NN173/2003, NN 67/08, and NN 36/09)
- The Electronic Document Act (NN 150/2005)
- The Electronic Signature Act (NN 10/02, NN 80/08)

The Electronic Signature Act aims to create public confidence in the operation and usage of electronic signatures and to encourage the widest possible usage of electronic signatures and electronic document exchange through open telecommunications systems. Simultaneously, the Act strives to create space for more intense electronic commerce action, which is increasingly becoming imperative for achieving competitiveness in world markets. Accepted guidelines of entering the Croatia in the European Union seeks legal and regulated system in which the area of electronic business and commerce together with the legal validity of electronic signature are set as the basis for the application of the Law on Electronic Signatures [6].
The law regulates the conditions for the usage of the electronic signatures in computer networks and provides the legal framework for the provision of certification services. Based on this law, the advanced electronic signature is, also, provided.

9. CARNet CERT

CARNet CERT (Croatian Academic and Research Network Computer Emergency Response Team) is a national center for prevention and elimination of problems related to computer network security. The purpose of CARNet CERT has been helping Internet users in Croatia in the implementation of proactive measures to reduce the risk of computer security incidents and to assist in combating the consequences of such incidents.

Although, primarily intended for systems engineers, CARNet CERT users are the final users of the Internet in Croatia.

CARNet CERT tasks are:

- Establishment of adequate coordination and cooperation in solving security incidents in which at least one party involved is Croatian
- Education of users and work on preventing computer security incidents
- collecting and distributing security advice, recommendations and tools
- Cooperation with relevant institutions to develop appropriate legislation to monitor the development of society using information technology
- initiate projects on security issues, setting up teams to deal with them and publishing the results
- Cooperation with other Croatian Abuse Services Internet Service Providers
- International co-operation with other CERTs through membership in Forum of Incident Response and Security Teams.

Since the mission of CARNet CERT is to establish a place of trust in the security of computer networks and systems in Croatia, this institution has maintained, for a long period of time, a coordinated communication with the Croatian ISPs abuse teams as well as representatives of the judiciary and police.

The results of these efforts include the National Program of Information Security in the Republic of Croatia and the National Program Implementation Plan for Information Security in the Republic of Croatia since 2005. [7]. These documents CARNet CERT put in the position of the top of the national CERT and the central authority in the national hierarchy of government and private bodies responsible for security incidents on the Internet and other networks based on the public communications infrastructure.

10. FINA

The major role in the development of a digital signature has FINA (Financial agency). FINA is engaged in transactions in the payment system, cash transport, providing business information and electronic services [8]. With this service FINA deals with the area of archiving, and provides support in the implementation of major state projects such as the HITRO.HR. Although the state-owned, FINA operates solely on market principles.

FINA is through the Registry of digital certificate the only provider of certification services in Croatia, registered with the Ministry of Economy, from whom he received permission to issue a qualified digital certificate. FINA has developed e-signature - application of advanced electronic signature that complies with the legislation of Croatia. The e-signature application is made for the electronic documents and data protection, guaranteeing authentication, integrity and inviolability in the daily usage of electronic documents.

11. Conclusion

The data protection issue and information security, as well as, business and financial transactions have become more important than ever.

The establishment of a public key infrastructure (PKI) based on the principles of asymmetric cryptography, is defined by a system that is easy to use and gives users a great degree of certainty. This infrastructure has been in recent years successfully implemented and applied in the field of online banking. The application of digital signatures is gradually assuming more and more momentum in the transmission of information. The adoption of the digital signature, as well as several related laws equate the value of a digital signature with his usual equivalents - signature. In the future we expect the reduction of paper and eventually abandonee of its usage. Documents in electronic format will take over their role, and the digital signature will be sponsoring a safe and successful operation.

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PRE-ACCESSION AID PROGRAMS OF THE EUROPEAN UNION IN CROATIA

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Abstract
Pre-accession programs of the European Union are preparation for the participation in the Cohesion policy and a framework through which the European Union provides financial support on a daily basis in the implementation of projects to encourage reforms and adjustments in order to utilize all the opportunities of membership in the European Union. The basis for the Croatian participation in EU Programs is Framework agreement between the Croatian and European Community on the general principles of the Croatian participation in Community Programs which opened the possibility for Croatia to participate in 25 programs.

Keywords:
Pre-accession programs, Cohesion policy, EU

1.Introduction

The process of accession into the European Union membership sets a challenge in front of Croatia considering the adjustment to the acquis communautaire, but it also opens up the opportunity of using financial resources from the European Union Budget. Croatia is set to become the 28th member state of the European Union on 1st July 2013. By joining the EU as a full member, Croatia will have access to financial resources. These financial resources will support their developmental goals and speed up growth and development of Croatian economy and society in their entirety. The Glossary of EU funds provides an overview and explains the meaning of numerous concepts that one needs to be familiar with in order to understand the European funds.

2. The first generation of pre-accession programs: CARDS, PHARE, ISPA and SAPARD

The first generation of pre-accession programs was focused on improving local development, democracy and human rights, on improving the quality of life, support for civil society organizations in providing social services and the promotion of employment. Funds from these programs was used by Republic of Croatia to implement the reforms necessary for accession to the European Union, for infrastructure investments in road and rail infrastructure, wastewater management, solid and hazardous waste management, water supply and sanitation and rural development and progress in agriculture. EU financed over 1000 projects worth more than 500 million euros. In the past few years, they hired more than 700 employees in state and public institutions and there was included 100 Croatian companies that provided services and work performed in the framework of the implementation of projects financed from EU pre-accession funds. The implementation of the projects included local and territorial (regional), governments and small and medium-sized enterprises which had the opportunity to hire new employees through the projects and thus affect the overall level of employment [1].
From the first generation of decentralized pre-accession programs, contracting has been completed for the CARDS, PHARE and SAPARD, and in the final stages for the ISPA program.

CARDS (Community Assistance for Reconstruction, Development and Stabilization) is EU program of technical and financial assistance approved in December 2000. whose main goal was to support the countries of Southeastern Europe for active participation in the Stabilisation and Association Process and the implementation of commitments under the Stabilisation and Association Agreement for the states that have signed such an agreement. Implementation of projects under the CARDS program lasted until 31 December 2009. The overall allocation for Croatia under the CARDS national program for the period 2001. - 2004. amounts 262 million euros, while the overall allocation for Croatia under the regional component is 179.6 million euros for the period 2001.- 2006.[2].

PHARE (Pologne et Hongrie - Aide á Restructuration Economique) is the program which was completely focused in 1997. on the pre-accession priorities and which became the main financial and technical instrument of the pre-accession strategy for candidate countries.
The aim of the Phare program is to prepare candidate countries for EU membership and to habilitate them for the full implementation of the acquis communautaire and the use of structural and cohesion funds after accession. The Republic of Croatia has been a beneficiary of the the Phare

program since 2005. In the Croatian case, the right to have the support had the projects that are consistent with priorities set by the Accession Partnership for Croatia, National Program for EU Integration and reports which were prepared by the European Commission on the Croatian accession process [3].
Phare program assigned to Croatia a total amount of 167mil.€ in 2005. and 2006.: 87 mil.€ in 2005. and 80 mil.€ in 2006.

ISPA is one of three pre-accession aid program of the European Union (with Phare and SAPARD) for the period 2000. - 2006. The main aim of the program is to help candidate countries to prepare for membership, and is intended to finance infrastructure projects in transport and environmental protection. The importance of using the ISPA program in Croatia is reflected in the fact that these are the first projects co-financed from EU pre-accession programs, also the first major infrastructure projects made in collaboration with the EU [4]. The basic prerequisite for using ISPA program is the creation of national ISPA strategies for the sectors of transport and environment - ISPA program basis. Strategy defines priorities for each sector and also provides a framework for the identification of projects, in other words, it sets the criteria which will be used for selection and evaluation of projects. Strategies must follow the relevant EU legislation and directives relating to specific sectors.

SAPARD (program (Special Pre-accession Assistance for Agriculture and Rural Development) has been launched in June 1999. By Council regulation (EC) No. 1268/1999 as a program which provides support to agriculture and rural development and prepares potential candidate countries for the use of agricultural and fisheries funds after acquiring the status as a member of the European Union. In the fiscal year 2006, Croatia has been granted 25 million Euros by the SAPARD program.
Agriculture and rural development project has provided for the investment into following measures:
•Investments into agricultural holdings (5 million €)
•Improvement of processing and selling agricultural and fishery products (9.75 million €)
• Development of rural infrastructure (10 million €)
• Technical assistance (0.25 million €) [5]

Figure 1. illustrates the allocation of financial resources within Pre-accession funds PHARE, ISPA and SAPARD in 2006. The largest amount of funding for 2006. was approved by the PHARE program.

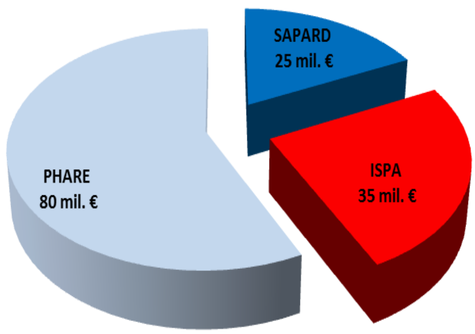

Figure 1. Funding project proposals within Pre-accession programs PHARE, ISPA and SAPARD in million €, 2006. [5]

The successful usage of allotted funds was confirmed by contract rates of agreed programs which exceed 90 per cent. An even more important fact is that contracts have agreed upon all prearranged programs and all program goals were completed while the percentage under 100 per cent refers to public procurement savings.

3. Pre-accession program IPA

Instrument for pre-accession assistance is a new instrument of pre-accession assistance for the period 2007-2013 replacing former programs CARDS, PHARE, ISPA and SAPARD. The financial value of IPA program for a period of seven years amounts to 11,468 billion Euros.
The main goals of IPA program are helping candidate countries and potential candidate countries to harmonize and reinforce EU acquis communautaire and preparations of states for the usage of Structural funds.
IPA program, as a new legal and institutional framework of providing pre-accession help is aimed at financing strengthening of institutions meant to accomplish the assignments put forward by the European Union membership, cross-border cooperation, strengthening of traffic infrastructure in order to provide a better access to boundary regions, especially railway and inland waterways as ecologically acceptable means of transport, as well as the establishment of waste management center and modern systems of water supply, the construction of business infrastructure in underdeveloped areas and the creation of knowledge-based society.
A special component of IPA program was intended for the development of human potentials through the strengthening of employment possibilities, especially for the groups in unfavorable positions, the encouragement of better education and skill improvement as well as bigger worker and trade adaptability to market needs.

The Republic of Croatia has been a user of IPA program since the year 2007 until being accepted as an EU member. The Ministry of Regional Development and EU Funds was in charge of the overall coordination of IPA program in the Republic of Croatia, while the Ministry of Finance represents the leading financial management. This unique pre-access instrument for the help in pre-access period differentiates two groups of countries:

• Countries with a status of potential candidate for EU membership (Albania, Bosnia and Herzegovina, Montenegro and Serbia)
• Countries with a candidate status for EU membership (Croatia, Macedonia, Turkey) [6]

When it comes to candidate states for EU membership, European Union, apart from the above mentioned forms of support, provides funds for financing projects of complete coordination of national laws with the legal EU legacy, full implementation of coordinated legislation, as well as program users' preparation for the enforcement of cohesive and agricultural Union policy.

IPA program consists of five following components:

Component I – Transition assistance and institution building

- Political criteria
- Economic criteria
- Ability to assume the obligations of membership
- Development of civil society dialogue
- Supporting programs

Component II – Cross-border cooperation

- Participation in cross-border operational programs with member countries (Hungary, Slovenia, Adriatic)
- Participation in cross-border operational programs with IPA countries (B. and H., Montenegro, Serbia)
- Participation in transnational operational programs (SEE, Mediterranean region)

Component III – Regional development

- IIIA – transport – support infrastructure projects in railways and inland waterways
- IIIB – environment – support infrastructure projects in solid waste and water management
- IIIC – regional competitiveness– support competitiveness initiatives and regional development initiatives

Potential beneficiaries are public administration bodies, public and scientific institutions and business community (SMEs)

Component IV – Human resources development – supports measures for employment incentives, education and social inclusion. Potential beneficiaries are public administration bodies, public institutions, social partners and NGOs.

Component V – Rural development – continuation of SAPARD program [6]

Table 1. illustrates the distribution of financial resources through the above mentioned pre-accession funds.

Table 1. Financial allocation of EU Pre-accession programs 2007. - 2011. [7]

CARDS	2001: 60 mil.€	
	2002: 59 mil.€	
	2003: 62 mil.€	
	2004: 81 mil.€	**Total: 262 mil.€**
PHARE	2005: 87 mil.€	
	2006: 80 mil.€	**Total: 167 mil.€**
ISPA	2005: 25 mil.€	
	2006: 35 mil.€	**Total: 60 mil.€**
SAPARD	2006: 25 mil.€	**Total: 25 mil.€**
IPA	2007: 141 mil.€	
	2008: 146 mil.€	
	2009: 151 mil.€	
	2010: 154 mil.€	
	2011: 157 mil.€	**Total: 749 mil.€**

The distribution of financial resources was adopted by the European Commission through a Multi-annual indicative financial framework for IPA program which includes a three-year period 2010-2012.

Above mentioned document has defined indicative amount of financial resources assigned to state candidates and potential candidates by the European Commission for EU membership. European Commission assigned 910.2 billion Euros to Republic of Croatia in the period up to year 2012 as shown in the table 2.

Table 2. Financial allocation of IPA program for Croatia in the period 2007-2012 in mil. € [8]

Components of the IPA Program	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
IPA I	49.60	45.60	45.40	39.50	39.96	40.90
IPA II	9.70	14.70	15.90	16.20	16.54	16.90
IPA III	45.05	47.60	49.70	56.80	58.20	59.30
IPA IV	11.38	12.70	14.20	15.70	16.00	16.00
IPA V	25.50	25.60	25.80	26.00	26.50	27.30
TOTAL PER YEAR	**141.23**	**146.00**	**151.20**	**154.20**	**157.20**	**160.40**

4. Preparations for the usage of EU funds

Cohesion policy is one of the most important European Union shared policies. In the fiscal period 2007-2013 its value amounts to 308.00 billion Euros out of 864.30 billion Euros from European Union total budget. Financial ‘weight’ of this policy reflects the proportions of socio-economical differences within the European Union, as well as the political importance of cohesion for the project of united Europe. Additional development funds from the EU level are a way of strengthening all areas and the citizens of European Union for the possibility of using the advantages of common merchandise market, capital, working force and services: a wider market, greater work and education mobility, greater service options, etc.
EU contribution to sustainable economic growth of member countries is carried out by governing EU funds, as well as national funds to priority investment in accordance with strategic goals.
The Republic of Croatia, as a member country, will take part in the EU cohesion policy and in this way acquire additional support for a faster economical development which will contribute to Croatian competitive strength on the European market. In October 2010, Croatian government has rendered a decision on strategic documents and institutional framework for the usage of EU funds in the Republic of Croatia [1].
Republic of Croatia will use the assets from the European fund for the regional development, European social fond and cohesive fund. It is highly important to prepare high quality projects in order to start with bidding procedures and secure just absorption of given funds.

5. Conclusion

Freedom and unity as main ideas on which EU was based are constantly accomplished through the freedom of movement, competitiveness and economic growth, single market and currency, a connection between citizens by encouraging the feeling of belonging and the collaboration of member states in order to create an environment of security, peace and justice. By entering into the EU we will be actively involved into mutual policies. One of the most important policies is cohesion policy which is an expression of bonding and solidarity between member states.

Partnership, as the most important principle of cohesion policy demands willingness from everyone: government institutions, local and regional government, public institutions, trade associations, entrepreneurs, economic and social partners, to use the financial support from the European fund with mutual effort and cooperation, in order to create new working places, to encourage competitiveness of Croatian economy, investment into education and new skills, development of traffic infrastructure and environment protection. During the usage of pre-access help programs, until now, more than 1000 projects at the value of 500.000 billion Euros have been signed. Local units, non-profit organizations and entrepreneurs were applying with their projects to biddings. Over 450 were given an opportunity to develop their capacity through pre-access programs, as well as materialize their ideas and change unemployment rates by employing new employees. All of them are an important basis for the preparation and implementation of quality projects which will be financed through future funds.

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IS YOUTH ENTREPRENEURSHIP IN CROATIA NECESSITY OR OPPORTUNITY DRIVEN?

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Abstract

This paper shows the structure of Croatian youth entrepreneurs in manner of entrepreneur entry motivation. What is the main reason of Croatian youth to run a business, is it opportunity or necessity reason? Which motive chase young people to go into entrepreneurial world? Is there more necessity reason because of current economic crises in Croatia? To find out answers to these queries Global Entrepreneur Monitor database 2010 is used with 2000 respondents. Also it is shown that there are dependences between age groups and entry motivation itself. Overall, on behalf of findings, it is shown a few possible reasons to justify results.

Keywords: entrepreneurship, motivation, age group, youth

1. Introduction

Many authors wrote about links of entrepreneurship and economic growth. Accordingly, Van Praag and Versloot [1] concluded in their paper which was based on 57 recent studies of high quality that contain 87 relevant separate analyses, that entrepreneurs have a very important role in the economy. However, it is also important to state that positive influence on economic growth depends on certain context and that specific countries situation matters.

This paper does not question the importance of the influence of entrepreneurship on the economic growth but rather explores the most important factor of this phenomena which is a person who undertakes entrepreneurial activity – entrepreneur, and does not stop there but looks at specific population of youth entrepreneurs and furthermore explores their motives.

Notably, the literature and study of youth entrepreneurship is rather modest and still relatively recent. Moreover, there is even less literature/research analyzing motivations of young entrepreneurs. Even though, the youth entrepreneurship is an under explored field in academic debates the academic and policy focus is inevitably growing. There are two reasons for this growth: the first is related to increased number of youth unemployment and second is the need for greater competitiveness, skills development and entrepreneurship as way to address growth issues [2].

Accordingly, the most recent poll undertaken by Kauffman foundation shows that more than half of ‘millennials’ want to start their own business [3]. Although this indicates only US situation the similar situation is in other countries. Does this mean that young people are eager to take an initiative and an advantage out of the economic crisis or on the other hand they see entrepreneurship as way how not to be unemployed?

In addition it is important to note that there is no general agreed definition of youth entrepreneurship, and since there is no unique definition of youth entrepreneurship it is proper to define the entrepreneurship in general in order to have a picture what is the phenomena that the paper explores. Universally accepted definition of entrepreneurship is that entrepreneurship is a process that involves the discovery, evaluation and exploitation of opportunities, in order to produce new products, services, processes, or ways of organizing markets [4]. Now when we have the definition of entrepreneurship we have to define who the young entrepreneurs are. Similarly to the problem of defining the entrepreneurship there is not agreed definition of young entrepreneurs, which calls us to define our target population. Therefore, for the purpose of this paper we define young entrepreneurs as population aged between 18-34 years (according to groups defined in GEM database that was used later in the paper) and since we use GEM database these are TEA active persons. Nevertheless, one has to keep in mind that this is not a homogeneous group that means that this group could be divided in several subgroups (18-24; 25-34) which on the other hand means that each of these sub groups has different characteristics. These differences could be seen in work experiences, additional education, priorities and other attributions.

After definition of the first variable we have to explain what the motivations of young entrepreneurs are. Motivations underlie the new venture formation are complex and have long been of interest to entrepreneurship researchers [5]. Nevertheless, motivations are very important factor that is largely determined by personal characteristics of entrepreneurs, such as education, starting capital and experience, while also dramatically influences the level of success, the number of employees, and company revenue [6].

In entrepreneurship literature, in general entrepreneurs can be divided into two groups in relation to motivation. There is a group of entrepreneurs who have become entrepreneurs because of necessity and those who recognized a business opportunity. First ones, driven by necessity, are those who have entered self-employment (or entrepreneurship) because they had no better options for work, while the opportunity entrepreneurs have chosen to start a business out of opportunity even when they had other employment possibilities. This typology 'replaced' previously used categories of 'pull' and 'push' factors (or pull and push theory of entrepreneurship motivations). However, in practice it is hard to distinguish between these two motivations since they often overlap [6].

More importantly, this paper looks at difference between different age group and their motives. The populations of youth entrepreneurs are often analyzed/seen in relation to their older counterparts. Therefore in that relation youth entrepreneurship has its own specific dimensions compared to entrepreneurship in general. In that respect young entrepreneurs differs from their adult/elder counterparts in a number of different characteristics. Young people have fresh ideas, different education than elder people (digital), they are less likely to have responsibilities like mortgages and families thus are less cautious. On the other hand older people have more experience, contacts and capital [7].

Moreover, motivations differ from country to country according to level of development. Thus, according to GEM in factor driven economies (less developed ones) there are more entrepreneurs in younger group compared to other types of economies, and there are more necessity than opportunity driven entrepreneurs [7].

There is a certain gap in the research regarding the youth entrepreneurship and especially of young entrepreneur's motivation. Even more there is hardly any works that analyze Croatian youth entrepreneurship and their motive.

With this paper we will try to fill above mentioned gap of lack of empirical analysis of youth entrepreneurship with specific focus on Croatian situation. Thus, the purpose of this paper is to get better insight into young entrepreneurs' motivation in Croatia. In order to support our standing that there are more young entrepreneurs in Croatia that are necessity than opportunity motivated, the youth group of early state active entrepreneurs (TEA index) will be compared to other age groups, and also the two groups of motivations (necessity vs opportunity) will be compared (among each other) and between different age group. In addition the GEM (2010) database will be used.

2. Methods

This study is based on behalf of data of Croatian Global Entrepreneurship Monitor Adult Population Survey for 2010. (APS Croatia GEM 2010). GEM is dedicated to the measurement of global entrepreneurial activities and their contribution to economic growth. This initiative involves comprehensive and empirical analyses of the entrepreneurial activities in various countries. To ensure the same level of comparable, reliable and uniform data, the same method of collection data is used across all of the countries. Croatia segment of GEM is conducted on annual bases with the sample size of 2000 respondents for 2010 year.

In addition, GEM represents an international project started in 1993, in which Croatia participates since 2002. Main goal of the GEM project is monitoring and analyzing of entrepreneurial activity for each country involved into research.

One of important variable that is used from GEM database represent indicator of entrepreneurial activity in early stage, from which is possible to calculate Total early-stage Entrepreneurial Activity Index (TEA Index). TEA index can be calculated for each country separate or for each category within same database. Index is calculated using the GEM variable *Involved in Total early-state Entrepreneurial Activity (TEA10),* which indicates whether is respondent involved in early state entrepreneurial activity or isn't. It can be in state "*yes*" or "*no*". For example in particular case is used to measure entrepreneurial activity among age groups of participants. As it was mentioned before APS GEM Croatia obtains 2000 record/people/interviewees out of which 5.52% are involved into entrepreneurial activities in the early stage (TEA index for Croatia).

Entrepreneurial activity of the nascent (who decide to start a business venture) entrepreneurs and new business owners (business owners whose entrepreneurial activity is measured by having paid salaries for more than 3 months, but less than 42 months), measured by the ratio of the number of such entrepreneurs (start-up) in the sample of the adult population, aged 18 to 64, is expressed through TEA Index. These are called start–up entrepreneurs and both with established entrepreneurs (business owners who are entrepreneurially active for more than 42 months) represent all categories of entrepreneurial activity.

In the focus of this paper is categorical variable which describes age groups of respondents described with question: "Would you be willing to indicate the range that best describes your age?" (AGE7c - variable) AGE7c variable is than subdivided into five age groups: 1) [18-24], 2) [25-34], 3) [35-44], 4) [45-54] and 5) [55-64]

Regarding the statistical method Chi-square test is used to test independence over categorical variables. Additionally, using the frequency tables feature (Statistica software tool), detailed review and distribution of motivation cross age category variable have been shown. Motivation variable is associated with TEA10 variable and represent the reason and motivation of entrepreneur to start a new business (TEA10MOT). It represent categorical variable that can be in one of three states: necessity, opportunity or other motive

3. Results

To make better insight into distribution of TEA active respondents ordered by age groups, *Table 1* is shown.

***Table 1**. Distribution of TEA active respondents categorized by age groups [8].*

Age group	Count	Percent
18-24	6.6	7.41%
25-34	27.4	30.8%
35-44	30.4	34.17%
45-54	20	22.5%
55-64	4.6	5.12%

It is clear that lack of sufficient data at some age groups can impair strength of our results , but also it can be seen that if we take our extended target group 18-34 (which is composed by two groups 18-24 and 25-34) it yields that group size is 38.21% and represent the largest group among all others.

To get close to research question, it is necessary to look through motivation perspective of respondents among age groups variable (*Table 2*). As it is mentioned before, motivation variable answer the question whether early state entrepreneur is engaged by opportunity or necessity motive.

***Table 2**. Motivation of TEA active records categorized by age groups [8].*

Age group	Opportunity	Necessity
18-24	4.07	2.53
percent	**61.66%**	**38.34%**
25-34	22.12	2.65
percent	**89.29%**	**10.71%**
35-44	13.53	16.47
percent	**45.10%**	**54.90%**
45-54	13.95	5.70
percent	**70.98%**	**29.02%**
55-64	3.15	1.41
percent	**69.03%**	**30.97%**
All groups	56.83	28.77
percent	**66.39%**	**33.61%**

Out of all groups the age group 18-24 is ranked as second to the rate of necessity driven entrepreneurs, and is ranked just after the group age form 35-44 years old. However, the group aged from 25-34 has the lowest percentage of necessity (10.71%) and the highest level of opportunity driven entrepreneurs (89.29%). It can be seen from *Table 2,* that the most of Croatian entrepreneurs have started a business out of recognizing an opportunity (66.39%). Thus, the opportunity based motive is predominant in all groups except the one form 35-44 age. Moreover it can be seen that young entrepreneur age group 18-34 is more opportunity motivated (75.48%) than elder group 35-64. (*Table 3.)*

***Table 3**.Young and senior entrepreneur motivation [8].*

Age group	Opportunity motive	Necessity
18-34	**75.48%**	24.52%
35-64	61.70%	**38.30%**
All groups	66.39%	33.61%

Another interesting result rises from the dependence of different age groups and motivation index (*Table 4)*. Namely $\chi 2$ test shows a statistically significant difference (Pearson Chi-Square, M-L Chi square p=4.81%, 3.48%). Among age groups (all of them) and TEA motives, accordingly, we can conclude that there is dependence. Also independence between groups 18-24, 25-34 and motivation is tested, but with no significant result.

***Table 4**. Dependence between age and motivation [8].*

p= statistical significant difference; cs=Chi-Square

Age	Pearson Chi-	M-L Chi-square
all groups	p=4.82%;	p=3.48%; cs=16.58
18-34	p=11.11%;	p=8.42%; cs=16.58

4. Discussion

The overarching goal of this paper is to investigate the motivations of young entrepreneurship in Croatia. By using GEM (2010) Croatia database we aim to analyze the motivations of Croatian entrepreneurs in relations to age groups of entrepreneurially active persons. In that respect we compared youth group with other age groups, and also compared two groups of motivations (necessity vs opportunity). In that respect, our findings do not support our hypothesis that young Croatian entrepreneurs are more necessity driven. On contrary our findings show that young entrepreneurs in Croatia are more 'opportunity driven' which means that more young entrepreneurs have taken advantage out of business opportunity.

These findings are contrary to previous research findings where it was found that young entrepreneurs are more necessity driven [9] These could be explained by the reason of choosing that specific the research counties (since the previous research investigated the Latin American countries) or maybe the time when these results were conducted (first half of 2000th). On the other hand, our findings actually support the findings of previous GEM Croatia reports that indicate that throughout years more and more TEA active population is categorized as opportunity driven entrepreneurs. This is more important if we know that the dominance of TEA Opportunity over TEA Necessity increases the entrepreneurial capacity of a country, because those who decide to be entrepreneurs because of a business opportunity, are in fact more oriented towards business growth than those who became entrepreneurially active because their situation forced them into it [10]. For example, while the most common age group (TEA active) in 2005 was that between 35 and 44 years (when those who entered entrepreneurial activity because of necessity dominated); the most common age group in 2006 was that between 25 and 34 years. Our results show that highest TEA active is in 35-44 years group while just slightly below is 25 and 34 years old group which has indicates that this group obtains prevalent number of TEA opportunity, while on the other hand the group 35-44 that shows the highest TEA necessity out of all other groups. More importantly, we have not measured TEA motivation index but just insight into table shows that TEA opportunity prevail across all groups which means that over years the situation improved. Before we start with the interpretation it is important to settle down certain assumptions. Firstly, in the introduction we presented some characteristics of youth and elder entrepreneurs. Young entrepreneurs are characterized by fresh ideas, new knowledge and skills, faster and easier decision making, higher risk taking propensity while, and on the other hand elder counterparts are more experienced, more connected and have more starting capital. The balance between these characteristics could be observed trough TEA index in the brake even point where these two groups are equally represented (*Table 1*). These two represent age groups 25-34 and 35-44. At this point where these groups have relatively similar indicators of activity (TEA) the main difference is in different motivation that led them into the entrepreneurial activity. To emphases motivation difference between these two groups, data from *Table 2* are selected and showed in *Table 5.*

Table 5. *Significant motivation differences between age groups 25-34 and 35-44 [8].*

Age groups	TEA (%)	Opportuni	Necessit
25-34	30.8 %	89.29%	**10.71%**
35-44	34.17 %	45.10%	**54.90%**

Even though that both groups have relatively equal entrepreneurial activity, motives for entering into entrepreneurial activity is drastically different. Certain reasons for this one could be found in current socio-economic crisis that Croatia has been going through. Namely, with recession rate of unemployment has risen. Therefore unemployed person probably found solutions in self-employment (especially those 34-44) that are less attractive to employers in relation to their younger counterparts. On the other hand, younger groups have retained into education system and have prolonged their higher education period, meaning firstly on the youngest group (18-24), since this young groups has very weak chance into the labour market in this period when the labour market is contracted. This group probably sees their opportunity through acquiring new knowledge and skills and finding their own answer on the market by starting new business. Therefore it seems that this group of young people have chosen entrepreneurship as the option/an opportunity. However, it is even more important to identify other characteristic of this group, for example: in which field have they started their businesses: high tech or low tech; are they more educated than others and what is the rational of turning the crisis into an opportunity. Deeper insight is crucial for better understanding these findings. Another important issue is distinguishing those that are active out of necessity to these that have taken an advantage out of opportunity within the same groups (25-34) and (35-44).

Since we got the results that are different from the previous analysis (of Croatian and other counties situation) it seems significant to further investigate have the entrepreneurial environment and culture progressed over the time in the way that has become supportive to entrepreneurial activities. Moreover, in order to get whole picture about youth Croatian entrepreneurs and their motivations drive it is important to see how many youth entrepreneurs firms survive and get matured and how these indicators position Croatia in relation to other countries' experience. Therefore, we support further research in this field especially regarding the Croatian situation since there is insufficient amount of empirical research and evidence.

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INSTITUTIONS, HAPPINESS AND ECONOMIC GROWTH IN THE CULTURAL SECTOR

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Abstract
The EU Member States either belong to the coordinated or the liberal cultural financing model. The role of the State is determining in both models, but there are differences in the forms and the quality of State intervention, which creates the puzzle that some countries (France, Hungary) using quite similar models are not able to produce almost the same level of economic performance, while other countries using contradictory models (France, the United Kingdom) are reaching almost the same level of economic growth in their cultural sector. In this article the focus is on the analysis of the role of institutions (informal and formal) in the economic performance of the cultural sector. The argument is that institutions matter and they have a determining role in the economic performance of the cultural sector, as those countries' cultural sectors perform better in economic terms, in which countries the formal (cultural policy and laws on culture) and informal institutions (beliefs, norms, attitudes, culture) are in harmony and the existing cultural policy is in force for a longer period of time. To demonstrate the assumption the following variables of 18 EU Member States are tested first with comparative then with correlation analyses: culture index, intellectual property rights index, gross national happiness index, cultural policy being in force (number of years) and the cultural sector value added to GDP.

Keywords:
cultural policy, cultural financing, formal and informal institutions, the role of the State, European Union

1. Introduction

The first chapter is focusing on institutions. In the second chapter the literature on happiness of the society is introduced, how it can increase economic development. In the main chapter first the EU Member States are analysed with comparative method, then the results are checked with correlation analysis. The article ends with the conclusions of the research.

2. Institutions Matter

North [4] defines institutions as follows: "Institutions are the humanly devised constraints that structure political, economic and social interactions. They consist of both informal constraints (sanctions, taboos, customs, traditions and codes of conduct), and formal rules (constitutions, laws, property rights)". This definition suggests that institutions have a role in the political, economic and social action. In this article a segment of the whole political, economic and social era of the European Union Member States is analyzed. In the article the focus is on how institutions have an influence on cultural policy, the economic performance of the cultural sector of the Member States and the happiness of the society. The latter is important as not only institutions can increase happiness, but happiness can have an effect on the growth of the cultural sector.

The informal and formal institutions differ in characteristics. Informal institutions are norms, customs, beliefs, traditions and religion. They are spontaneously created and embedded into the actors' beliefs and norms. The roots of the informal institutions are in the actors' individual preferences. These types of institutions change in an endogenous way very slowly (100–1000 years). They cannot be modified by top-down formal rules. If formal rules are not in harmony with the informal institutions then the formal ones won't become part of the actors' norms and beliefs, so institutional stickiness does not function properly. Pejovich [5] describes this phenomenon in his Interaction Thesis:

"If changes in formal rules are in harmony with the prevailing informal rules, the interaction of their incentives will tend to reduce transaction costs in the community [that is, the cost of making an exchange and the cost of maintaining and protecting the institutional structure] and clear up resources for the production of wealth. When new formal rules conflict with the prevailing informal rules, the interaction of their incentives will tend to raise transaction costs and reduce the production of wealth in the community."

Boettke et al. [6] also emphasizes the importance of the harmony of informal and formal institutions. They create a model to demonstrate the connection between these two types of institutions. Boettke et al. categorizes the formal institutions into three groups (Figure 1).

- IEN institutions are indigenously-introduced endogenous institutions. IEN institutions are those we associate primarily with spontaneous orders. These embody the local norms, customs and practices that have evolved informally over time in specific places. Language, for instance, is an IEN institution [6].

– IEX institutions are indigenously-introduced exogenous institutions, those we associate with the internal policies created by national governments. For example, federalism in the United States is an IEX institution. Federalism represents a state-constructed institution designed by Americans. Similarly, the British Parliament constitutes an IEX institution. It is a designed institution of British construction. [6]. National cultural policies also belong to this category.
– FEX institutions are foreign-introduced exogenous institutions. FEX institutions are those we typically associate with development community policy. For instance, a legal system change introduced by the development community in a reforming nation would constitute a FEX institution. Although the decision regarding such a change ultimately lies in the hands of the indigenous government, the policy change is chiefly the creation of outsiders and the institutional change is constructed [6]. The supranational level rules of the European Union are examples of these types of institutions.

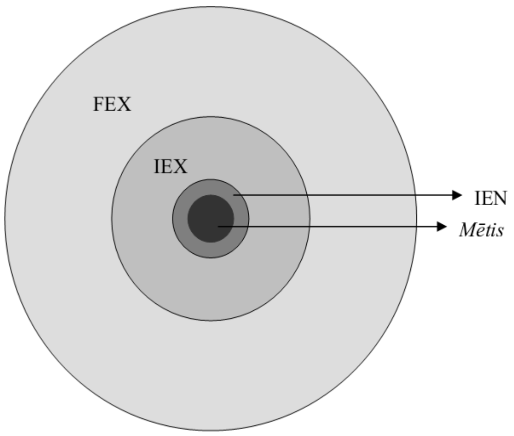

Figure 1. Institutional Stickiness (Source: [6])

The metis symbolizes the most embedded traditions, norms and beliefs of the society. The further the formal institutions are from the metis, the lower the stickiness of institutions is.
This model also emphasizes if there is harmony among institutions, the political, economic and social life performs better, in one word the society's welfare is higher.
Claudia R. Williamson [7] also examines and describes the role of institutions on economic performance. The findings of the article suggest that the presence of informal institutions is a strong determinant of development. In contrast, formal institutions are only successful when embedded in informal constraints, and codifying informal rules can lead to negative unintended consequences.
All the previous literature referred to suggests that the harmony of institutions is determining in economic development and performance as well. Based on the findings the assumption is that institutions have a determining role in the economic performance of the cultural sector too.

3. Happiness Matters

Scitovsky [8] in his famous book "The Joyless Economy" writes how happiness and economic development have effect on each other. He emphasizes that people with higher salary have a better chance to be happy, but it is not automatic that the richer people are, the happier they are. This puzzle raises the question if not money makes us happy, how people can be happier. Scitovsky argues that too much uncertainty [1] stimulates unhappiness, while little uncertainty can motivate people to find new solutions [goods, services, ideas] to reduce it. If demands are satisfied by new solutions it can make people happier. This theory shows that Schumpeterian creative destruction influences the level of happiness in a society in a positive way.
Sen [9] argues that the actors' freedom is also an important factor in economic development. He believes that if people have bigger freedom to do things which are valuable to him, there is a bigger chance that the newly created goods, services and ideas will be valuable for other actors of the society too. Freedom matters as it generates creativity, which helps give more options to fulfil the actors' needs, decreases uncertainty, so in an indirect way it has positive influence on people's happiness.
Brooks [10] states that freer economies mean happier populations. Happier people are more often volunteers. Free and happy people donate more and give more to charity. The non-profit sector also functions much better in happier countries as there is trust between the government [policy- and decision- makers] and the market actors. All these previously mentioned activities and institutions are key factors in the case of the cultural industry as well.
But how an institutional background can be created, which supports the actors' free activities, increases certainty and happiness. The answer is the intellectual property rights protection. Towse

[1] Knight [13] makes distinction between risk and uncertainty. Risk is predictable so the actor can estimate the possible outcome and the result of his action, while in case of uncertainty the outcome is unpredictable and the actor cannot estimate it. In case of uncertainty judgement and intuition are required rather than calculation.

[11] argues that the copyright and the intellectual property rights protection have a key role in making the cultural sector more efficient. In many cases copyright can be more motivating for productivity than direct government support. The freedom and the safety of property rights are proven to make people happier [12]. Happy people are more likely to increase their activities and consumption in culture and recreation, which has a positive effect on production and employment.
These previously introduced arguments can be demonstrated and explained in the following model (Figure 2):

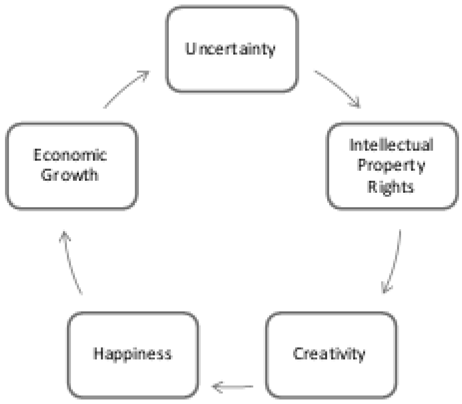

Figure 2. Institutions, Happiness and Economic Growth in the Cultural Sector [Own Model]

Actors are always seeking for something new, which activity is full of uncertainty. This uncertainty can be reduced if the actors' intellectual property rights are protected. The intellectual property rights law has to be in harmony with the people's norms, beliefs and attitudes as it was introduced in the previous chapter on institutions. Intellectual property rights protection makes the result of the actors' action more predictable, which increases certainty and creativity. The more creative solutions and ideas are created, the more options are available to satisfy the actors' demands and needs. The process of searching for new solutions and the moment of satisfaction makes people happier. Happier people are more productive [14], which generates economic growth. However economic growth increases competition, motivates more actors who want to enter the market, which increases uncertainty and the process starts again.
Based on the literature the argument is that happiness is a determining factor in the economic development of a country. In the main chapter of the article the proof of how institutions and happiness influence the economic performance of the cultural sector in the European Union is demonstrated.

4. Institutions, Happiness and Economic Performance in the Cultural Sector

The theory suggests that institutions and the level of happiness of the society affect economic performance. This argument has relevance in the case of the cultural sector as well. To prove the assumption 18 European Union Member States data is going to be analyzed and compared[2]. The variables used in the comparative analysis are:

- Intellectual Property Rights Index (10 scale) – symbolizing formal institutions (2009)
- Culture Index (10 scale) – symbolizing informal institutions (2009)
- Cultural Policy in force (years) – own categorization based on Compendium Country Profiles (2011)
- Gross National Happiness Index – the level of happiness of the society (2006)
- Cultural Sector Value Added to GDP – (%) (2006)

Based on the statistical data it can be stated that theory has relevance in practise. In those countries where informal and formal institutions have higher scores, gross national happiness index is also higher, and cultural policy has been in force for a longer period of time and the cultural sector value added to GDP is also higher.
The countries, which use the liberal cultural financing model all have high scores in the examined variables. The Scandinavian countries put theory into practise in the most efficient way. Among the countries which use the coordinated cultural financing model there are good examples too. France, Belgium, Germany, Italy and Spain can be mentioned.
All the post-socialist countries have lower scores in all variables, which result suggests that more than twenty years after the political change the fast created western-type of institutional system is very unstable and the transition is still in progress. It is worth referring to Kornai's [15] thesis, which perfectly describes this puzzle.
"…if the reform on property ends faster than the transformation of the political, juridical and cultural [informal] institutions, it can happen that the latter will be managed in a quite slow and harmful way, accompanied by serious social costs".

The results of the comparative analysis are also tested by using correlation analysis. First it is tested whether institutions (informal, formal, cultural policy) have effect on the happiness of the society. Gross national happiness index is the dependent variable in the model (Table 1).
The results show that there is strong positive correlation between intellectual property rights index and happiness on 1 percent significance level. The correlation is slightly weaker but still relevant in the case of culture index on 1 percent

[2] There is relevant and comparable statistical data on these countries. There are no data available from the same year.

significance level. The used cultural policy being in force also strongly correlates with the level of happiness on 5 percent significance level. This latter variable symbolizes the predictability and certainty of institutions. Long-lasting cultural policy can be created if formal and informal institutions are in harmony. The results support the argument that institutions matter in case of the happiness of the society.

Table 1: Correlation on Gross National Happiness

	IPR Index	Culture Index	Cultural Policy in force
Gross National Happiness Index	0,708***	0,675***	0,577**
Significance Level	0,001	0,002	0,012

*** 1 % Significance
** 5 % Significance
* 10 % Significance

The most robust results of the research are on whether institutions and happiness have an influence on the economic performance of the cultural sector. The dependent variable is the cultural sector value added to GDP in the model (Table 2).
All the variables show positive and significant correlation to cultural sector value added to GDP. Intellectual property rights index and cultural sector value added to GDP correlation is strong on 1 percent significance level. The second strongest correlation is between gross national happiness index and cultural sector value added to GDP. Culture index and cultural policy being in force are correlated weaker on 10 percent significance level with cultural sector value added to GDP.

Table 2: Correlation on Cultural Sector Value Added to GDP

	IPR Index	Culture Index	Gross National Happiness Index	Cultural Policy in force
Cultural Sector Value Added to GDP	0,614***	0,424*	0,541**	0,433*
Significance Level	0,007	0,08	0,02	0,072

*** 1 % Significance
** 5 % Significance
* 10 % Significance

The results suggest that the argument that institutions matter and they have a determining role in the economic performance of the cultural sector has relevance, as those countries' cultural sectors perform better in economic terms, in which countries the formal (cultural policy and laws on culture) and informal institutions (beliefs, norms, attitudes, culture) are in harmony, the level of happiness of the society is higher and the existing cultural policy is in force for a longer period of time.

5. Conclusions

In the article the focus was on the analysis of the role of institutions (informal and formal) in the economic performance of the cultural sector. First in a literature review it was demonstrated why institutions matter. Then the focus was on how happiness has influence on economic performance. The results suggested that both institutions and happiness are highly correlated with economic performance. Then the evidence was tested on the cultural sector of the European Union Member States. First a comparative then a correlation analyses were used to prove the assumption that those countries' cultural sector performs better, in which the informal and formal institutions are in harmony, the level of happiness of the society is higher and the used cultural policy is in force for a longer period of time. The results show that institutions have a strong influence on economic performance, happiness and cultural policy.
If the institutional system is predictable, accountable and the formal institutions are in harmony with informal institutions then the economic and social well being of the society is higher.

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MOTIVATION FOR ENTREPRENEURIAL ENGAGEMENT

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Abstract
Entrepreneurship has never been as important as today when the world faces major challenges that go beyond the global economy, when the entire concept is challenged and when an entire series of established practices, routines, behaviors are also challenged. Entrepreneurship is an extraordinary force taking us forward with its great influence on growth, recovery and social progress and by supporting innovation, generating employment and strengthening the foundations of society, as well as by encouraging the values of freedom and self-responsibility. Subject of this research was the hierarchy of needs according to Maslow, self-assessment of work success, as well as to answer the question what animates and motivates the individual for working well and using its resources to work and how motivation affects job satisfaction in private companies. The results show that the increased enthusiasm and commitment of entrepreneurs is affected by factors required for personal development, higher achievements, responsibilities and rewards. Given the uncertain and risky business conditions both in Serbia and in the region, the priority is to meet economic needs which would be followed by development. Studies have shown that those who strive for meeting these needs are faced with several options. The factors that motivate an entrepreneur for turning his conventional career into entrepreneurial career are factors that are pushing him (limited income, limited work prospects, inflexible management) and factors that are pulling him (the profit motive, the sense of freedom and independence, creativity). The sample included respondents of various demographic features (gender, age, education, place of work, occupation) from Serbia.

Keywords: entrepreneurial engagement, Maslow's hierarchy of needs, motivation for entrepreneurship

1. Introduction

The motivation for entrepreneurship is the main lever of entrepreneurial engagement, that is starting an entrepreneurial venture and its sustainability/success are directly associated with entrepreneurial motivation.
Efficient and effective development of human resources requires the consideration of people's interest, in addition to corporate objectives. Indeed, the company uses human resources as a means of achieving its goals, but people also use the company to achieve their personal interests (salary, experience, affirmation, etc.). The development of motivation for entrepreneurship engagement is in the basis of development of the overall economic system.
Working motivation is the dominant problem in entrepreneurial engagement. In the past decades we have witnessed an unprecedented dynamics in the functioning, organisation and location of business firms. We have seen the birth of global firms, but also the emergence of many promising small and medium size enterprises (SMEs). Large-scale concentration was accompanied by outsourcing at aworld-wide scale. And ICT developments have made the locations of industrial plants and offices increasingly footloose [1, 2 and 3].
If we look at the man and the organization he is employed, and the way that harmonizes its own internal value system with general system value which was set up in work organization and technology through formal and informal processes through organizational culture, we can see the interdependence of the compliance and motivation to work. The degree of compliance of the internal system of values with the general value system will determine the degree of personal motivation for certain actions. This means that the personal motivation to work is higher when the internal value system of the employee fits into the demands of work and general value system of the company. Motivation decreases when the personal value system is less compatible with the requirements of the job. If, for example, the primary values of the employee are independence and creativity, and the performed tasks simple, monotonous, and over-controlled without any original and creative solutions, it is natural that the motivation of the employee weakens in time. On the other hand, someone whose values are accuracy, accountability and security, is likely to be more motivated for this type of tasks.
Great interest in the problem of motivation has essentially three reasons: improving productivity, efficiency and creativity of work, advancing the quality of work life in organizations, as well as strengthening the competitiveness and success of the company. In most of our companies there is a lack of continuous measure of motivation, so the motivation of employees is linked mainly to

monetary incentives. The degree of attention that successful global companies pay for the motivation and employee satisfaction is high and it is approached holistically and conceptually. On the other hand in recent decades, the results of the motivation of employees in our country, observed a reduction in salary incentives, which brings into play other factors of employee motivation, which provide greater opportunities for self-realization. The motives for participation are the mostly in the function of cultural and economic factors, as well as in learning patterns.

Motivation for entrepreneurial engagement are largely the function of cultural and economic factors, as well as learning patterns. Entrepreneurship involves human agency. The entrepreneurial process occurs because people act to pursue opportunities. People differ in their willingness and abilities to act on these opportunities because they are different from each other. We argue that the variation among people in their willingness and ability to act has important effects on the entrepreneurial process [4, 5 and 6].

Maslow hierarchy of human needs is nowadays one of the best known and most widely used theories in practice, which is understandable considering that its settings can be an effective instrument of motivation of all employees. Maslow presented his thoery for the first time in the article *The theory of human motivation* (A Theory of Human Motivation), in 1943. Starting from the conception of man as an integrated personality in organizational unit, it is considered that there is a structure of basic needs that are of universal nature, relevant to each person and that the study of motivation has to focus on ultimate goals, desires and needs of people. Maslow's human motivation viewed as a hierarchy of five needs starts with the lowest physiological or basic needs, and develps through the need for security, the need for affiliation (social), the need for self-esteem (respect) and finaly finishes in the need for self-actualization.

Recent research on entrepreneurship has focused largely on macro level environmental forces [7, 8] and the characteristics of entrepreneurial opportunities [9]. Researchers adopting this focus have rightly criticized much of the existing empirical research on the role of human motivation in entrepreneurship [10].

2. Research methodology

Research subject

The subject of this research are the factors of motivation for entrepreneurship as observed through the prism of hierarchy of needs in a candy manufacturing organization in the stage of development and market penetration in order to increase the performance of both individuals and the organization.

Research goals

The study aims to identify the degree of satisfaction of specific needs and evaluate the significance of the organization's specific segments for the employees, to assess the potential for entrepreneurial efforts.

Research hypothesis

A general hypothesis has been defined based on the research subject and aim:

H1: There is a satisfaction of needs based on Maslow's hierarchy of needs that would form the basis of entrepreneurial engagement.

The research sample

The survey was conducted among employees of varying demographic characteristics (gender, age, position in the company, educational background). 100 employees were investigated in this research out of 180 employees working in the company X.

The research instrument

The questionnaire that was used in the research is designed for research purposes, representing a modified instrument of the Maslow's levels of needs, shows the degree of agreement with specific statements.

Data processing

After surveying the employees of the company X, the answers were processed in the SPSS software package.

3. Research results

Survey results were compared through frequency analysis

The gender of respondents was as follows: 57% females and 43% males. 3% were executive staff and 7% were managers. The age distribution was as follows: 55 respondents were younger than 30 years of age, 33% were aged 31-40, 59 % were aged 41-50, while 3% were older than 50. The level of the respondents' education was as follows: 2% were with elementary school, 3% were highly qualified, 32% were with three years of high school, 49% were with four years of high school, 10% and 4% had higher and faculty education, respectively. As many as 80% of workers considered that the physical conditions in the workplace are of great importance to their work, while 17% of them is not quite sure, and 3% of workers believe that it does not matter.

As to the individual awards for the success at work, it is important for most respondents (78%), 21% of them were not sure, while 1% reported that it is not important. The company awards the title of the best worker on an annual basis.

Most employees (75%) want to give their best in doing their job, i.e. to invest a maximum effort in order to maximize their job performance, 22% were not sure, while 3% disagreed. Thus, we can see that more than 82% of respondents confirmed that it is highly important for them to work using high-quality equipment, 13% were not sure that it is highly important, while 1% believed that it is not important. The company X is a rather young company and owns the latest equipment which greatly facilitates the employees' work.

Job security, as manifested in permanent employment, is highly important for 81%; 18% of respondents were not sure, while 1% believed that it is not important for them.

As considered by 88% of employees, business policies and rules of conduct are highly respected; 11% of respondents were not sure of this, while 1% disagreed with this statement. 82% of employees were satisfied with material rewards, 17% were not sure, while 1% was dissatisfied. As evidenced by the employees, chances for the advancement at work are very good – 76% were very satisfied, while 24% had no clear position regarding this item. Interpersonal relationships as job motivators are important for 82% of employees, 16% were not sure, while 2% believe that interpersonal relations are irrelevant for doing their jobs. As reported by 75% of employees, the superiors' approval for getting a job well done means much to them, while 22% were not sure of the existence of such a positive feedback effect, while 3% reported that the approval is not important.

Most employees (51%) believe that they are skilled to perform their functions in the company, 45% were not sure and 4% believe that they are insufficiently skilled. These responses regarding the employees' competence self-assessment are problematic both for the individuals and the organization given that a large percentage of employees reported that they are not sure about their own competence.

More than 60% would have the courage to initiate new job-related activities if necessary, 31% were not sure, while 6% would not dare to do so.

The results indicate that the lower hierarchical levels of need among the respondents are satisfied, and the sufficient levels of hierarchical needs of higher levels, such as the need for rewarding, successful, independent activities are established as well. The problem can be sensed in the assessment of their own level of expertise, which is only half of respondents confident in their own competence. A significant result of which could contribute to the entrepreneurial engagement is that over 60% of employees are ready for independent entrepreneurial venture, which belongs to the fifth group of needs and is also linked to the entrepreneurial efforts.

We believe that all the hierarchical levels are important for entrepreneurial motivation. Starting your own business in our conditions is so far mostly directed towards meeting basic levels of need. Modern business conditions impose different attitudes towards entrepreneurship, i.e. small and medium size enterprises.

4. Conclusion

Based on these results, the conclusion is that the hypothesis on satisfying the needs of employees, as measured by the scale of hierarchy of satisfying the needs – according to Maslow, is confirmed. The system of motivating employees with financial-based compensation must include also compensations of intangible nature given its purpose satisfying various human needs. The more needs it satisfies, the more effective it is in achieving organizational goals. Given that needs are not merely of material nature but also social and psychological (the individual's needs of growth and development, the need for knowing the own capabilities, status, cooperation and social contacts, security, etc.) the system of material incentives should be supplemented by mechanisms that indicate the importance of each individual and his contribution to the organization. Thus, there are a number of personal and social factors that need to be investigated, and they are important for the development of entrepreneurial engagement. One of them is the motive of achievement. Within the research domain of personality traits and entrepreneurship, the concept of need for achievement (nAch) has received much attention. Johnson [11] conducted a traditional review of 23 studies, which varied regarding samples, measurement of nAch, and definitions of entrepreneurship. Based on this group of studies, Johnson concluded that there is a relationship between nAch and entrepreneurial activity—in this case, nAch distinguished firm founders from other members of society. Further, they concluded that nAch might be particularly effective at differentiating between successful and unsuccessful groups of firm founders hanea, [4]. Thus, nAch could play a very useful role in explaining entrepreneurial activity.

Entrepreneurial engagement has an important role in the organizational development and requires the consideration of issues of openness to entrepreneurship from the aspect of all disciplines which can contribute to its development.

5. Acknowledgement

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THE ROLE OF INNOVATIONS AND EDUCATION OF ENGINEERS IN THE CATCHING-UP PROCESS IN SERBIA

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Abstract
Just like any other country going through transition in the region, Serbia is characterized by an intention to reach the level of those countries most developed in technological and organisational aspects, which is a process known as catch-up. In this paper, our interest will be focused on the interconnectedness between know-how, offered by higher education, and the concept of innovation, understood in the broadest technological and social sense, in the catch-up process.

Keywords:
innovations, metal processing industry, higher education

1. Introduction

The idea of transformation of the economies in poor countries with the aim of reaching the developmental stage of the highly developed countries is called the catch-up process. Countries with different economic development levels converge towards the same structural and organisational form of economy. This means that poorer countries tend to replicate the methods of production, technology and institutions used in developed countries.

In the words of Jeffrey Sachs, a Professor at the Harvard University, the fundamental condition for convergence lies in the political system, because this is a process that cannot be achieved in developing countries which have closed economic policies. The problem of progress in development can be solved only through free trade and openness practiced by any given country. In their study, which included a range of 111 countries covering the period from 1970 to 1989, Jeffrey Sachs and Andrew Warner concluded that growth in development in the world is characterized by the following features:

- Industrialised countries have a growth rate of 2.3% per capita;
- Developing countries with open economies have a growth rate of 4.5% per capita;
- Developing countries with closed economies have a growth rate of 2% per capita.

These views can be characterized as traditional economics theory, which implies that new technologies can ensure that underdeveloped countries reach developed countries. Taking into consideration that there are non-economic factors that cannot be taken as a constant, it can be assumed that absolute convergence is hardly realizable.

2. General Characteristics of the Situation in the Metal Processing Industry in Serbia

Apart from machines production, the manufacture of metal products in Serbia participated in the national economy's export and import, contributing approximately 2.65% to it, and hence the deficit in foreign trade in those products amounted to 206.0 M US dollars (before 1990 this activity was marked by a steady surplus in foreign trade). In 2006, the scope of material production of other machines and equipment was 31.4% less in comparison to 2000 (that is, only 5-6% of the pre-transition maximum) [2].

3. Characteristics of the Higher Education in Serbia

From the standpoint of a part of the younger generations who decide to take up their professional course within the scope of technical professions, we can acknowledge that, in Serbia, just like in the entire region, there is a trend of declining interest for the metal processing profession. From the perspective of scientific resources in Serbia, a specific feature can be observed in its developmental policy, which is the fact that there is a negative demographic trend, having a direct impact on the creation of scientific youth, and the formulation of a higher education policy. It is estimated that the number of emigrants from Serbia is approximately 3.5 million, which is 50% of the population living in Serbia [3]. In the period from 1990 to 2000, around 73,000 residents left Serbia, of which 17,000 had higher education

[4]. The negative trend was continued also after 2000, in slightly reduced intensity, so around 50,000 people left Serbia, of which 2,000 had higher education [4].
Characteristics of the higher education in Serbia are as follows:

- Higher education system comprises 7 public Universities (105 Faculties), 6 private Universities (53 Faculties), 80 colleges of vocational studies (academies of applied studies).
- Total number of students: 202,000 (2008-2009).
- Of all the students, 180,000 enrolled for Masters` studies (89%).
- Average studying time at faculties is 7.69 years, while at colleges it is 4.2 years.
- Average mark at studies is 7.96.
- In 2007 appropriation for education amounted to 3.5% of GDP.
- Republic of Serbia's budgetary appropriations for education amounted to 10%, whereof 19% was for higher education and 2% for the Ministry of Education and national councils and institutions for education.
- Only 15% of the population in Serbia has higher education, which is low in comparison to the EU average figure, which amounts to 22%.

4. Analysis of the Findings of the Study "Analysis of the Engineers' Education Impact on the Development of Innovation Activities in the Metal Processing Industry in Serbia"

For the requirements of the study "Analysis of the Engineers' Education Impact on the Development of Innovation Activities in the Metal Processing Industry in Serbia", representatives from ten Faculties and ten metal processing companies have been surveyed and interviewed, whereby they gave their opinions about the state of education and innovation activities in metal processing companies in Serbia in the period 2008-2010.
The research highlighted the problem that it is impossible to obtain precise information from Faculties and companies, on graduate students, their business and professional engagement and achievements, costs of innovation activities, financial effects of realized innovations etc. In the event that such a situation occurs, it is a common practice, in the field of survey research, to carry out PEST (Political, Economic, Social and Technological) analysis of gathered data, which constitute a general picture of the diverse influences from the macro-environment. Questions that were asked had a descriptive character, comprising **political and legislative factors** (assistance from public structures, legal regulations related to international cooperation, social incentives), **social and cultural factors** (qualification structure, social organisational factors, subjective standpoints – demographic problems, generational viewpoints, personal affirmation etc.), **technological factors** (innovation activities development, investments in research – acquisition of ready-made technologies and equipment, technological level – technological cooperation). Descriptive statistical analysis of binary responses was applied ("yes-no" information), that is, any factor observed is either relevant or irrelevant.

5. Analysis of the Findings of the Survey in Metal Processing Companies

The survey in metal processing companies showed that the majority (70%) of them implement ready-made solutions, while 30% manage to perform innovation activities within and outside of their respective companies. Companies are oriented primarily at technology transfers, that is, the acquisition of machines, equipment and software. As regards limiting factors, lack of information on markets and market domination exercised by other companies were stated by respondents as the most prevalent factor (100%), due to the fact that the Serbian economy is relatively closed in comparison to global markets. Opening of the Serbian economy toward the EU was the influence that led 90% of the respondents to an understanding that it is required to meet the EU regulations. In 50% of the companies surveyed innovation activities are limited by the migration of professionals in all fields who are leaving for developed countries. Figure 1 shows factors limiting innovation activities in the period 2008-2010 as follows:
1) Excessive economic risks;
2) Huge costs of innovations;
3) Availability of financial resources for innovations;
4) Lack of information on new technologies;
5) Lack of information on markets;
6) Market domination by other companies;
7) Uncertain demand for innovated goods and services;
8) Lack of qualified personnel in your company;
9) Requirement to fulfil State regulations;
10) Requirement to fulfil EU regulations

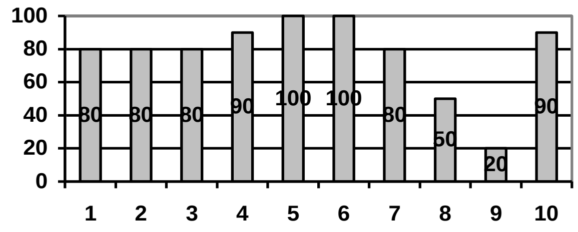

Figure 1. Factors limiting innovation activities

Among the respondents, 20% opted for investment projects for research and development outside of companies in the period 2010-2012, and the same number plan to invest in research and development within their respective companies. This fact points out that companies in Serbia do not undertake research projects with significant scope. The survey showed that there is 100% propensity to purchase ready-made technologies and appropriate equipment, which induces spontaneously high interest in employees' education in 60% of the companies surveyed. Growing competition is forcing Serbian companies to make projects on marketing investments (90%). On the other hand, in only 20% of the companies, did their plans include projects on services provided by higher education personnel, ranging from design to acquisition of external know-how (expert consultants), which is a negative fact.

Figure 2 shows type of planned investments for the period 2010-2012, with the purpose of realizing new products, as follows:

1) Research and development within companies;
2) Research and development out of companies;
3) Acquisition of machines, equipment and software;
4) Acquisition of external know-how;
5) Training;
6) All forms of design;
7) Marketing costs.

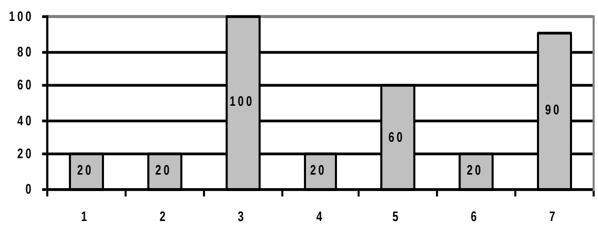

Figure 2. Types of planned investments

It is observed that Serbian metal processing companies have insufficient economic potential to access a broader international stage, because all the participants from the survey stated unanimously that they are oriented primarily toward the domestic market. Findings of the analysis indicate that engineers most often participate in innovation activities, which is the case in 90% of the companies. All the participants of the survey stated that engineers have been abandoning their companies. In the case of technicians (60%), it is a matter of problems regarding redundant technological labour, personnel retraining to service activities in the field of small-scale industry, shift to work in agriculture etc.

Figure 3 indicates primary reasons why companies are abandoned by personnel who took part in the innovation process, as follows:

1) Low income;
2) No possibility of advancement;
3) No possibility of advanced training;
4) No innovation activities in the company.

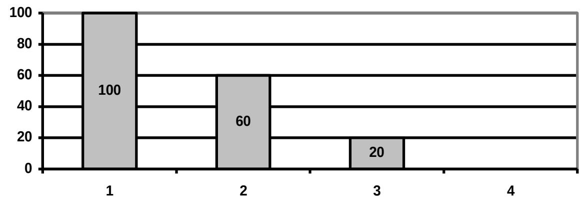

Figure 3. Primary reasons why companies are abandoned by personnel

6. Analysis of the Findings of the Survey in Technical Faculties

Only 10% of the surveyed Faculties had the opinion that efficiency is primarily achieved through the quick inclusion of students into Research and Development Faculty Programmes, while 20% of the Faculties believe that it is efficient to include of graduate students into their Research and Development Programmes.

Figure 4 indicates the most efficient field of Faculty work, as follows:

1) Efficiency in studying time;
2) Quick inclusion of students in Faculty Research and Development Programmes;
3) Quick inclusion of graduate students in Research and Development Programmes;
4) Quick inclusion of graduate students in business flows

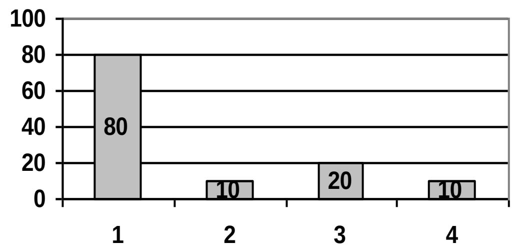

Figure 4. The most efficient field of Faculty work

There is a high percentage of discontent among the Faculty employees because of their low income (70%), which is only to be expected in conditions of economic crisis. Likewise, a clear picture has been obtained on the poor exchange between Faculties, which is also reflected in the limited opportunities for professional advancement (60%). A high percentage of discontent with the existing situation is primarily present among the younger generation of lecturers (Assistant Professors and Docents). Advanced training mostly boils down to personal initiative and private contacts, and there is no organised institutional assistance, either at Faculty or University level. The strategy employed by Faculties in developed countries is oriented toward multidisciplinary cooperation, which cannot be said for the Faculties in Serbia. Multidisciplinary cooperation in Serbia exists only in doctoral studies. Only 20% of the surveyed Faculties comprehend cooperation with designers. Cooperation with marketing experts is even lower, amounting to 10%. Data obtained from the survey on the state of industry show a rising trend in interest for marketing research of markets. This infers the conclusion that Faculties are yielding marketing analyses to economical assessments, without taking part by proposing their creative solutions.

Figure 5 indicates factors limiting innovation activities at Faculties. The impact of *economic factors* (1) comprises excessive economic risks, great costs of innovation, availability of financial resources for innovations etc. *Know-how factor* (2) refers to insufficient number of employees, lack of information on new technologies, lack of information on markets etc. *Market factor* (3) includes market domination by other Faculties, uncertain demand for innovative goods and services. *Legal factors* (4) include the requirement to comply with State regulations, as well as requirement to conform to EU regulations

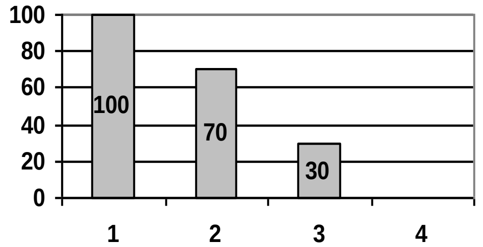

Figure 5. Factors limiting innovation activities at Faculties

Based on the data about the state of the metal processing industry, it is evident that there is a clear orientation toward the import of ready-made technological solutions and appropriate equipment. This fact is the reason why 40% of the Faculties take part in the retraining and upgrading of their current employees, which is an important source of material resources, both for the lecturing staff and the Faculties alike.

7. Conclusions

The findings of the study “Analysis of the Engineers’ Education Impact on the Development of Innovation Activities in the Metal Processing Industry in Serbia” showed what the current weaknesses are, as well as the positive aspects of the problem of the education of engineers in technical occupations and metal processing companies, with the purpose of searching for new integration and institutional solutions.Insufficient financial resources of the Serbian companies appear to be the most important limiting factor regarding investments in innovation activities of the Serbian companies. Investment and innovation activities are a huge factor of excessive economic risk, and therefore a clear orientation can be seen in the metal processing industry toward the import of ready-made technological solutions and appropriate equipment. This state of affairs leads to a reduced scale of research activities at Faculties, which also has a direct impact on the material situation at Faculties. Insufficient economic and innovation potentials of a large number of Serbian metal processing companies cause them to be predominantly oriented toward the domestic market and, to a lesser extent, the region. Only the most successful companies achieve export results on the markets of developed countries, through transformation of their proprietary capital. The situation is similar at Faculties, where innovation activities are directed primarily to the domestic users and, to a lesser extent, countries in the region. Low income at Faculties and in the economy is the most common reason for discontent and abandonment. Lack of clear perspectives and the uncertain market future of the metal processing complex as a whole provide reasons for a lessened interest in and orientation to this activity among young staff. The Developmental Policy in all transition countries suffers from the unfavourable demographic trend of scientific personnel leaving for highly developed countries.

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