TEAM 2011

3rd International Scientific and Expert Conference of the International TEAM Society

CO-MAT-TECH 2011
17th International Scientific Conference

Technics, Education, Agriculture, Management

October 19-21, 2011
Trnava, Slovakia

Conference Proceedings

TEAM 2011

Proceedings of the 3rd International Scientific and Expert Conference

with simultaneously organised
17th International Scientific Conference
CO-MAT-TECH 2011

19th – 21st October 2011, Trnava, Slovakia

The Conference is organised under the auspices of the International TEAM Society:

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

TEAM 2011, Proceedings of the 3rd International Scientific and Expert Conference

with simultaneously organised 17th International Scientific Conference **CO-MAT-TECH 2011**

19th – 21st October 2011, Trnava, Slovakia

Organizers	International TEAM Society and Slovak University of Technology, Faculty of Materials Science and Technology in Trnava, Slovakia

All papers are reviewed.

Publisher	University of Applied Sciences of Slavonski Brod, Slavonski Brod, Croatia, 2011
Printing	Garamond, s.r.o.
Editor-in-Chief	Jozef Bárta
Editor	Alena Prelovská
ISBN	978-953-55970-4-9

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50 years of laser – 50 years of a new tool in Manufacturing

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Abstract

The contribution deals with a short summary of 50th anniversary of laser invention from the aspect of its impact on manufacturing. Introductory part covers the most distinctive properties of laser irradiation and the most important features of laser-material interaction. The main part: Laser applications in manufacturing contain a list some milestones in history of laser applications. A brief review of laser based techniques with some examples and future trends is also included.

Keywords: Laser; Machining tool; Application; Manufacturing.

1. INTRODUCTION

Laser as a beam shaped source of intense energy which can interact at long distance had been predicted a long period before its experimental demonstration. The exact time connected with its 50th anniversary is considered to be May 1960 when Theodore Maiman constructed, demonstrated and published (in the August issue of Nature) [1] his achievements in experiments with a ruby laser. Only restricted community of specialists would have noticed this short announcement of what is now included among one of most important inventions of the 20th century. Next improvements, new theoretical and experimental breakthroughs which led to new types of lasers in early and mid-1960s paved the way to commercial use to the end of that decade.

According to [2] laser processing covered approximately 1/3 of 2010 annual revenues in laser industry. Fig. 1 shows a comparison with other fields of industrial laser market. Regardless of the important economic downturn of the late 2010s, the laser industry keeps long term growth and represents an important factor for further industrial improvements.

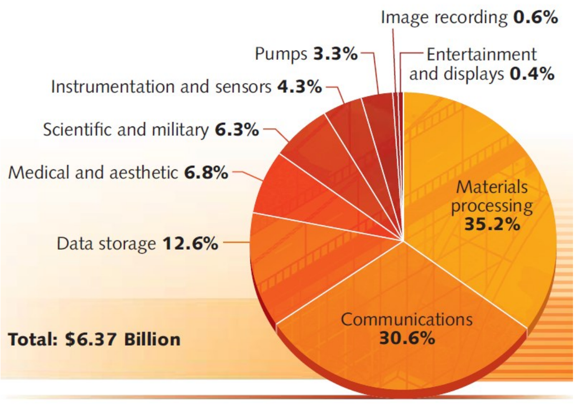

Fig. 1. Laser revenues by applications in 2010 [2]

The aim of the contribution is to give a brief report on laser technologies applied in manufacturing and their physical principles. Moreover, some important historical milestones in this field of application are presented and finally, an attempt for future evolution and expectation is included.

2. PRINCIPLES OF LASER TECHNOLOGIES

Laser technologies in manufacturing are based dominantly on thermal processes. Athermal processes – direct breaking of chemical bonds are not important for topic of this article. For better explanation and clarification what is main difference between laser and “traditional tools” it is important to define its physical properties from point of view of this application and then potential benefits in practical using.

2.1. Properties of laser radiation

From early 1960s up to today the laser generators has been evolving into a huge variety of systems with different wavelengths, output powers, active media or many other characteristics. One feature that all lasers share is the unique nature of light that they produce – a coherent, monochromatic beam of low divergence and high brightness.

Divergence is a measure of the tendency for the beam to spread as it propagates from the laser. The beam divergence should be small (preferably in order of 1.0 mrad) for better focusing of the beam energy into the machined workpiece.

The quality of a beam is a parameter of its focusability. It is connected with divergence and can be evaluated by various ways. The notation M^2 is mostly used and can be expressed by the formula:

$$M^2 = \pi d\theta / 4\lambda \qquad (1)$$

where d is the waist beam diameter, Θ is the divergence and λ is the beam wavelength. The lower the M^2 value, the higher the beam quality. The M^2 value for “ideal” (Gaussian) beam is 1 and “real” industrial lasers produce beams with $M^2>1$. Fig. 2 compares computer simulation of a Gaussian beam profile (left) with a profile of typical Nd:YAG laser (right) [3].

The intensity of interacted power onto the irradiated surface – power density – (I [$W.cm^{-2}$]) is defined as ratio between the power of the beam and the irradiated area. If we consider that the laser beam of high quality and 1 kW power can be focused at diameter of 0.2 mm we can expect the intensity in order of 10^6 $W.cm^{-2}$. That beam intensity related to temperature of black body radiation through the Stefan-Boltzmann law:

$$I = \sigma T^4 \qquad (2)$$

where s is Stefan-Boltzmann constant and T is absolute temperature of emitted (in our situation irradiated) area produces temperatures around 20,000 K which is sufficient to vaporize any known metal [4]. Such combination of high intensity and minimal influenced area does not have any counterparts in manufacturing technologies (excluding electron beam).

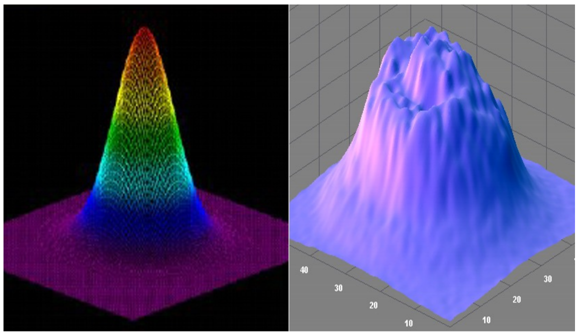

Fig. 2. Comparison of a Gaussian beam profile (left) with a profile of industrial Nd:YAG laser [3]

Laser irradiation exhibits uniform wavelength and can be highly polarised. Both these properties affect the amount of light absorbed in many material processing applications.

2.2. Laser – material interaction

When light strikes an interface at two different optical media – in our case the surface of a workpiece in air ambient – a fraction of energy (power) is reflected at the surface, a fraction is absorbed and under certain circumstances a part transmits. The absorbed part is attenuated according to the equation:

$$I(x) = I_0 \exp(-ax) \qquad (3)$$

where I_0 is the incident intensity, I(x) is the intensity reaching depth x from the surface and a is the absorption coefficient (reciprocal length). In practical situation, metals have high values of absorption coefficient and typical absorption depths are in nm-μm intervals but exact values depend on laser wavelength and material characteristics. In general – shorter wavelength means higher absorption/reflection ratio and higher absorption coefficient.

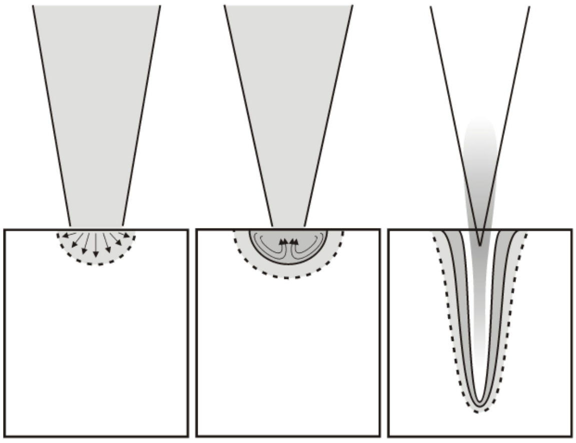

Fig. 3. The effect of power density on the interaction between a laser beam and workpiece surface under steady state conditions (a – surface heating, b – melting, c – vaporisation – keyholing) [4]

The absorbed energy of light is quickly (in picoseconds to nanoseconds) converted into heat energy and according to above mentioned principles of absorption we can consider it as a surface source of heat [5,6]. Under certain power density values the heating process behaves as a nonlinear system and there can be identified some distinctive threshold density levels. The applied power density (it can be effectively controlled by focusing and varying of a spot diameter of irradiated area) determines the principal mechanism of thermal interaction – heating (conductive heat transport), melting (convective heat transport in melted pool and conductive in heat affected zone) and vaporisation (combination of radiation, with convective and conductive mechanisms) as illustrated in Fig. 3. For example, power densities on order 10^2, 10^4 and 10^6 of W.cm^{-2} are required to heat, melt and vaporise structural steel using a CO_2 laser beam [4].

The results of a laser-material interaction depend on a wide variety of factors. Some of them play key role generally but another, on the other hand, becomes more influential above certain "threshold" levels only. The complex description and modelling of the laser based technological processes are still insufficient and there is plenty of room for further theoretical and experimental research. For brief illustration, Fig. 4 presents a process map according to the interaction time vs. power density relation. The boundary and the exact position of each of the processes is quite blurred in real application and depends on kind of material, surface state, laser wavelengths and so on. Experimentally meaningful area lies along the diagonal and it is depicted in grey.

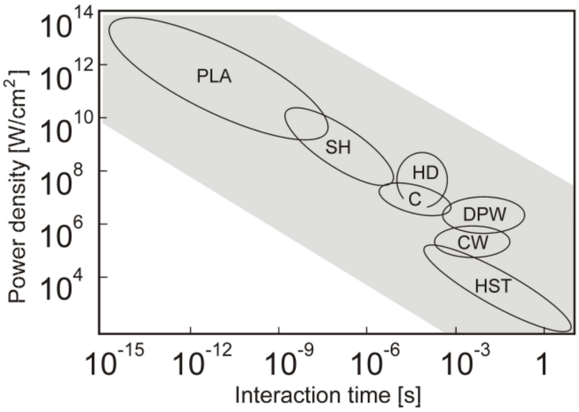

Fig. 4. Laser - material interaction (HST-Heat Surface Treatment, CW-Conductive Mode Welding, DPW-Deep Penetration Welding, C-Cutting, HD-Hole Drilling, SH-Shock Hardening, PLA-Pulsed laser Ablation) [7]

3. LASER APPLICANIOS IN MANUFACTURING

If we think about laser as a machining tool we can see its astonishing versatility in manufacturing and related applications. It could be quite a difficult task o find any restriction in material selection for laser processing. Laser has been successfully applied for processing of pure metals, alloys, ceramics, glasses, polymers, and composites, coated, homogenous or intricately structured materials in both laboratory experiments and industrial environments [8]. Laser light can be controllably produced in continuous or pulsed form. Output power spans orders from milliwatts to multi-kilowatts which enables fabrication from micro to macro scale [8]. There is visible a productive synergy in historical retrospection of laser applications in manufacturing: new improvements in lasers provided new opportunity for innovative solutions and new technological challenges drew the evolution of laser equipments.

3.1. Milestones in Laser Applications

Many key improvements and milestones have been occurred since the laser invention and it is a quite tricky task to select the most important among them. Very interesting selection published D.A. Belforte in [9] and his choice was based on subsequent three criteria:

did the application break new ground for industrial laser processing, did the application lead to major commercial markets over the intervening years, and did the development of the laser equipment used to process the application spin-off new product technologies for manufacturing. His final list of 10 of milestones includes namely: (1) Hermetic sealing of small electronic relays in the period 1973-75, (2) Ceramic substrate scribing in late 1960s, (3) Sheet metal cutting in 1967, (4) Drilling of turbine blades in 1970, (5) Tailored blank welding in 1983, (6) Stent cutting in 1992, (7) Rapid prototyping (also known as Additive Manufacturing) in 1987, (8) Micro-Via drilling in 1974, (9) Laser marking in the mid 1960s and (10) Electronic circuits adjustment in the late 1960s [9].

All above selected examples stayed behind the development of more reliable lasers producing of high quality beam, tailoring of pulse shape, incorporating of sophisticated adaptive controlling systems and so on. What is more important – they served as pioneers in this field and their success boosted further research and application effort.

3.2. Lasers for Manufacturing Today

Many different types of lasers and active media has been demonstrated stimulated emission but only a relative small fraction of them are useful for material processing. There is a set of general requirements for this group of lasers: ability to generate laser beam of high powers (in order of kilowatts) and high beam quality. Moreover, such lasers must exhibits long term operational stability in harsh industrial environments and compatibility with co-working systems. Finally, capital and operating costs are also important and must be balanced with provided profit.

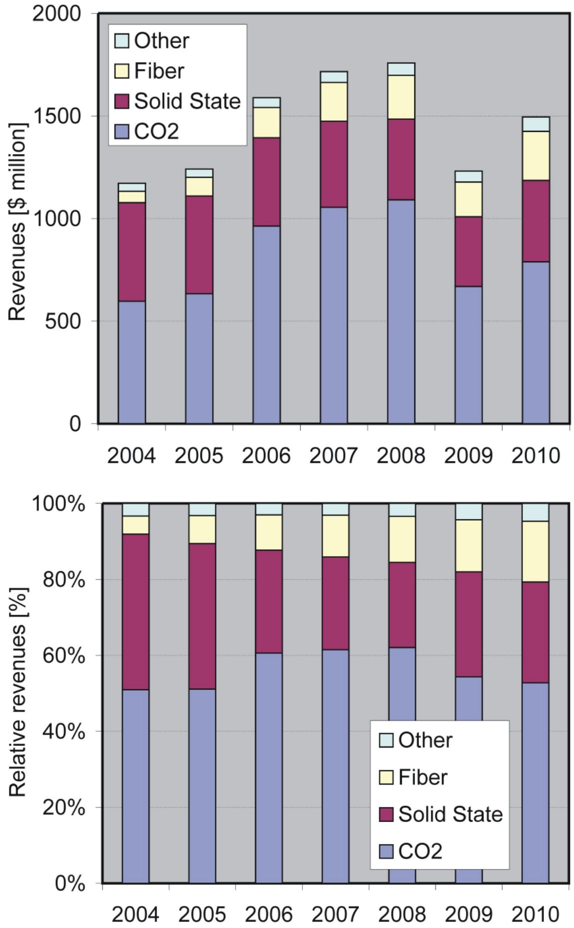

Fig. 5. Revenues by different types of lasers for materials processing in 2004 – 2010 [10]

The two types have been used since the dawn of the laser material processing: CO_2 and Nd:YAG lasers. They still hold the largest share in this sector, however other new types has emerged (semiconductor, excimer, fibre lasers). Especially expansion of fibre lasers is remarkable and they are expected to be a major rival for CO_2 and Nd:YAG lasers in the very next future. Fig. 6 shows a comparison among mostly used laser in material processing in the last 7 years [10].

3.3. Lasers in Slovakia

Early stages of laser manufacturing applications in Slovakia are connected with research activities in state research institutes such as VUMA (Research Institute for Mechanization and Automation), the Welding Research Institute and the Wood Research Institute in early 1980s. They employed imported laser generators and researchers got their first practical experiences with laser equipments and related applications.

In 1980 two research projects started at VUMA Nove Mesto n. V.: the developments of a 1 kW CO_2 laser and Nd:YAG laser (pulsed and Q-switched) for the electronic industry. As a result, the first laser radiation from the 1 kW CO_2 laser designed and built in Slovakia occurred in March 1983. The laser, an unstable resonator with a ring laser beam, was used for surface heat treatment and alloying applications. Over the next four years, three units were produced and used in technical universities and Welding Research Institute [11].

First commercial applications in private companies have appeared after economical transformation in 1989 and since then only tentative progress has been recorded. Foreign investors in 1990s paid little attention for research issues and their manufacturing plants with lasers were supported by own know-how only. The late 1990s and start of 2000s brought a state scientific institute International Laser Centre and new Slovak companies (Avantek, First Welding Company) which deal with laser research and commercial activities. Moreover, government scientific agencies support cooperation among universities and industrial companies by new projects of basic or applied research. A project of applied research guaranteed by Ministry of Education between International Laser Centre and Avantek can serve as an illustration. It was successfully finished in 2003 by designing and building of the first diode pumped solid state laser for micromaching in Slovakia [12].

Research activities at Faculty of Material Science and Technology SUT in Trnava are still based on sharing of experimental equipment with collaborating institutes in Slovakia or abroad. Nevertheless, it is a fruitful partnership and it promote coping with lack of infrastructural facilities and encompasses both teachers and students. Results include scientific projects, diploma works, PhD. thesis, commercial outputs and so on [13].

3.4. Examples of Laser Applications in Manufacturing

There are a large number of examples where laser beam is applied in manufacturing process. They can be classified in various ways based on factors such as role of the laser in certain process, working temperature, dimensions of affected area etc. Laser assisted processes employ laser irradiation in traditional technologies like metal forming and machining when laser heating reduces deformation strengths in material.

Another way is consider laser beam as a main processing tool and perform classification according to traditional approach: heat treatment (annealing, hardening), joining (welding, brazing), cutting, cladding, machining and so on. However, laser technologies have own special features which must be take into account when they are used in practical applications.

For instance, heat treatment, especially surface hardening of steels is based on a thermal cycle when cooling dynamics is important. Traditional methods use some cooling medium (water, oil). In contrast, laser quenching does not need any active cooling medium. Heat transfer caused by subsurface bulk mass is enough for inevitable heat flow and effective martensite transformation.

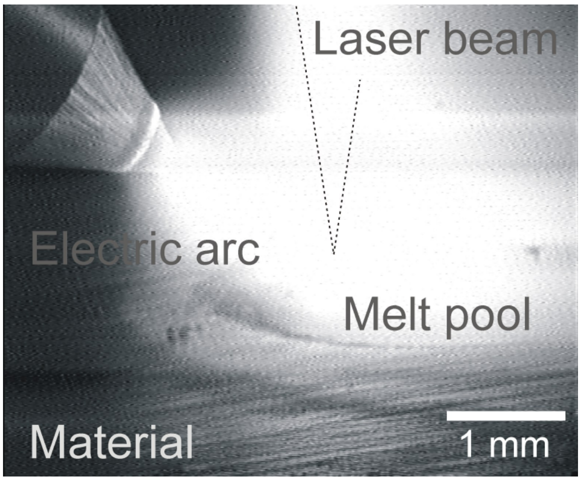

Fig. 6. Example of laser hybrid welding process

Another case of oddity is hybrid welding when traditional electrical arc heating source is combined with laser beam in common melt pool. The final effect of such hybrid process is not just superposition of applied heat sources but a new synergy. Relatively small inputs of laser power and electrical arc energy results in substantially higher welding speeds, amount of melted mass and with still proper depth/width ratio of fused zone [14].

Furthermore, laser brings completely new approaches which have no competitive equivalent in traditional methods. Rapid prototyping (Additive Manufacturing) based on Laser Stereolithography or Selective Laser

Sintering builds 3-dimensional objects directly from CAD models. The parts are generated in layer-by-layer manner using a scanned laser beam to locally solidify a liquid photopolymer resin or solid powder (metal, ceramics, composite) [8].

4. CONCLUSIONS

Laser is now an integral part of modern society covering a wide range of applications including manufacturing technologies. It revolutionized traditional material processing and recorded an unprecedented impact on quality, economy, innovation, non-conventional treatment of materials and still provides new inspiration, challenges and opportunity for engineers involved in this speciality.

It is quite difficult to foresee next evolution in this area. However, some trends which would be the most influential are considered as follow:

- More user-friendly complex turnkey systems
- New laser generators – higher quality of beam,
- New material challenges,
- Combining of different technologies during one technological operation,
- Improvement in adaptive controlling,
- Shortening of operation time – remote processing,
- Maybe, some unexpected surprise.

5. ACKNOWLEDGEMENTS

This work was supported by the Slovak Research and Development Agency under the contract No. APVV-0506-10

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Creativity and University – how does that fit together?

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Abstract

One of human skills – creativity - is very important resource for business practice in nowadays. This paper tries to describe more point of views on how and if really university and creativity are going together hand by hand. At the end of the paper are described the more important areas which must be taken into account by developing of creativity.

Keywords: Business; Education; Creativity; Potential.

1. INTRODUCTION

Human creativity is very important skill of people for success in private or in business life. According to a study by the Institute for Prospective Technology Studies, 70% to 80% of competitiveness and growth of enterprises will be based on new knowledge and skills of employees. This assumption is based on changes in the business environment of the 21st century – the continuing globalization of markets, intensifying competition, improving speed of innovation and the boom of information and communication technologies.

2. CREATIVITY AND BUSINESS PRACTICE

Creativity has been rightfully considered to be one of the main resources of the 21st century for business practice. Only the growth of creativity and mobilization of the human innovative potential can secure an access to the reserve that is essential for successful and humane development of economy and society.

Problems in companies that need attention are either new and often too complicated or too simple and routine, leading to blind and automatic solutions. The improvements of existing products, creation of new products, development of new advertising concepts, search for new forms of professional cooperation, development of new positive policies, or creation and implementation of changes, are all important tasks that companies need to solve.

The level of maturity of enterprises will be measured by the level and growth of their intellectual potential. It has already become evident that companies compete in the level of knowledge and skills of their employees and the ability (willingness) to use them in real life.

Creative employees are not just a fashion trend in the business practice. It is an objective necessity, a challenge of modern times. Creative employees need to be systematically educated. The ability to think and act creatively needs to be actively developed much earlier than on the company level. Therefore it is important from the perspective of education at universities as well.

3. CREATIVITY AND UNIVERSITY

In principle are universities very conservative institutions, and especially here in Europe, they have strong historical, cultural and economic rules and their own academic habits and procedures.

Universities are goal oriented and have specific ways of thinking based on pragmatism, on logic, analysis and synthesis. Universities are the source of knowledge and information, which are divided into particular areas and there are clear defined borders between them.

Universities make progress in science (they are science), do basic and applied research. Development in all aspects of human life would not be able without universities. Last but not least – universities certainly play important role in education; many of jobs are unthinkable without getting a specific university degree education. Universities mean intellectual, scientific and cultural treasure of each nation.

I strongly believe – universities can be justly proud of their tradition and all above mentioned attributes.

On other hand – we have here creativity – which breaks conservatism, habits, rules and tradition, works with freedom in thinking, is not based on logic and pragmatism, and is not goal oriented very often. Creativity tries to step over the borders, breaks fancies between areas.

It seems university (as a sign for conservatism and tradition) and creativity are two total different worlds and we can ask: "Are they playing together or do they face each other on the barricades?"

The answer is on the first sight very easy – of course not!!

Although universities mean tradition, it would hardly be possible to make development, science and research without creativity. Each university professor and teacher will confirm – one cannot educate and research without creativity.

But when we look at what university students say or think to this point we will get a little bit different answers.

To this topic was prepared a specific task and it was given to students of our University – to prepare a collage on "Creativity at University today and tomorrow" – some of the most interesting collage are showed at the figure 1.

Fig. 1. Collage "Creativity at university"

Another interesting point of view to the topic "University and creativity" was written by American writer, philosopher and teacher Robert Fulghum in his book „Uh – Oh"(YVE Books, New York, 1991)

He says that he is invited very often as a guest speaker at schools and universities, and sometimes at kindergarten. From his point of view, besides the size there are in principle not big differences between universities and kindergartens.

Both of these institutions serve education; offer possibilities and tools for writing and reading, work with words and numbers; both have facilities for scientific research – either laboratories or boxes with toys or equipment for plays; both have things for art-making.

But in kindergarten is everything concentrated in one area and each "student" has access to everything. At university are the resources in different buildings and the access to them is often limited.

But the most significant difference is in self-image and self-assessment of students.

Ask the students in kindergarten: "Who of you can draw?" And all hands go up. "Of course we can draw". "And what can you draw"? "Everything" - is the answer. "And what if I want you to draw a tiger, as he fights with the fire truck in the jungle?" "Of course and how big should it be?"

Next question – "And who of you can sing?" Again all hands up – "Of course we can sing!" "And what if you forget the words or the melody?" "Where is the problem? We create new ones!"

"Who can dance?" Again 100% agree. "Do you play an instrument? Can you count or read?" Yes, we are just learning it!"

The answers of students in kindergarten are always YES! Students in kindergarten are confident, trainable and willing to learn and their resources are unlimited. No limits, no borders in their minds.

Now try to put similar questions to the students at the university. Only a small number of students say yes, when we are asking if they can draw, sign. And often those who raised their hand response with all kinds of limits: "I can only draw the buildings; I can sing only in shower, or after two glasses of wine etc."

After question: Why all this limits? – The answers are: I have no talent; it is not the main part of my study; it does not fit the situation or I need practice for some months!

The opinions of students has changed from YES to NO, or YES, BUT!!!

What does it mean? What happens between kindergarten and universities with students? Where did the spontaneous YES disappear? – are the questions at the end of the story from Robert Fulgum.

However, at this place I don't want to answer the questions of Robert Fulghum – but I think one thing is clear – creativity belongs to university. There is not able to do research and education without creativity at universities. Last but not least universities should to support creative thinking of their students to fulfil the expectations of the practice.

4. HUMAN CREATIVE POTENTIAL

Human Creative Potential (HCP) means ability to act creatively and solve problems determined by what is the man's personality potential (personality competence) and what is the behaviour potential, also called action potential, action competence. Although defining boundaries for human creativity can be quite paradoxical, the creative potential can be expressed using the following formula:

$$\mathbf{HCP = PP + BP} \qquad (1)$$

BP –Behaviour Potential (action competence) reflects one's creativity supporting behaviour and practices, which include:

- open and flexible attitude – the ability to accept new things without rejection, with feelings and consideration,
- way of communicating with the surroundings,
- consistency and conscientiousness at work,
- ways of solving conflict situations,
- sense of group dynamics, teamwork, etc.

PP – Personality Potential (personality competence) is consisting of two elements:

$$\mathbf{PP = IQ + EQ} \qquad (2)$$

IQ – Intelligence Potential is a well-known way of evaluating the level of intelligence (known as intelligence quotient) which is more or less precisely measurable. In addition to specific professional expertise and methodological skills, and analytical-system thinking, it also includes specific professional knowledge associated with information development, general language education, knowledge of the social, economic and political context, and knowledge of other cultures.

EQ – Emotional Potential is known as emotional intelligence – its importance and development has significantly increased in the last twenty years. The opinions on the possibilities of scientific measurement of this component of personality differ, however it is a proven fact that the emotional intelligence has a crucial importance for creativity.

Emotional intelligence consists of several components, which can be summarized into the following five areas:

- awareness of one's own emotions, one's mental state,
- self–control, managing those emotions, tolerance of frustration, patience,
- self-motivation,
- empathy,
- social perception,
- ability to think in pictures and abstractions.

5. DEMAND ON CREATIVITY IN 21ST CENTURY

Using the formula no. 1 can helps to illustrate the past development of competence and outline the present and future demand on creative potential. (Fig. 2)

In the **first two thirds of the 20th century** the competences ware primarily focused at the area of logical, rational intelligence (IQ). This orientation gave direction to basic (general) education, methods of employees' selection, evaluation, and area of their development.

The last third of 20th century registered a shift into the area of emotional development, especially in the 1990's. This shift was primarily significant in the area of general education, evaluation, and further employees development. The previous systems of educations (from elementary schools all the way to university education) were focused on the development of the IQ and did not pay enough attention to the EQ development. This component of human personality got an increased attention in the last decade and this development was valued as very important and highly appreciated among the employees. Analytical-logical skills are still necessary but on the other hand social-psychological skills have gained an increased importance, which form the personality potential.

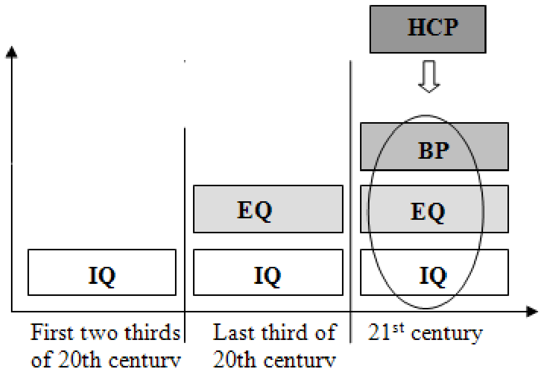

Fig. 2. The development of competences

Creative competences demanded **in 21st century** are added by behaviour potential (action competence) of employees. A high level of personality potential (IQ and EQ) by itself is not sufficient if one is not able to "sell" these personality qualities in communication, presentation, negotiation, problem solving, etc.

6. DEVELOPMENT OF CREATIVITY

Development of creativity competencies can be viewed as development of the following two areas:

- Area of employees' emotional potential (EQ),
- Area of employees' behaviour potential (action competence).

The development needs to be perceived in a mutual context. (Fig. 3)

$$\begin{aligned} HCP &= PP + \boxed{BP} \\ PP &= IQ + \boxed{EQ} \end{aligned}$$

Fig. 3. The areas of development of creativity

7. CONCLUSION

The image of current environment can be illustrated using a simple analogy, as a wild river and a branch sticking out from its bottom. Two types of people can be associated with this image. One type of people can hold on to the branch tightly and successfully fight with the strong current – this is called a static security. The other types of people act like fearless swimmers – they prefer dynamic security and build on their strong self-confidence, development of their own capabilities, and the ability to swim. This kind of dynamic security means freedom, seeking one's own limits and going beyond these limits. It is a synonym for creativity.

8. ACKNOWLEDGEMENTS

Author of this paper is cooperating with Creativity Academy, Vienna, prof. Erich Weisbier.

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Trends in development of the sector of agricultural engineering

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Abstract

The contribution was prepared with the aim to present the most important trends which can be observed in the sector of agricultural engineering as this sector significantly effects the effectiveness and productivity of agricultural production. As a main method there was used the analysis of the basic principles of the EU Common Agricultural policy, its goals and principles. It was stated that the EU Common Agricultural Policy can be considered as main driver effecting the function the sector of agricultural engineering and its development. The basic principles of this policy are implemented also into the development of the European agricultural machinery industry. Based on the analysis it was found that the implementation of the new technologies in the sector agricultural engineering will be effected by the rapid increase of the population, by global climate changes, by increased production and use of biofuels and growing demand for renewable raw materials. The development of agricultural machinery was demonstrated by using the case of new John Deere 7R Series Tractors where a lot of improvements, innovations and intelligent solutions have been implemented. As satellite guidance systems based on GPS are generally considered as an effective tools allowing to increase the accuracy of the field machine passes and subsequently to obtain a significant benefits (reducing skips and overlaps of the working widths, reducing fuel consumption and other inputs, etc.) in a paper there is given the comparison of the manual guidance with satellite guidance of the tractor-machine set during given field operation (stubble harrowing). The approach as a whole can allow to understand the basic trends in development of agricultural engineering and its effect on the knowledge of human factor. .

Keywords: Agrotechnology; Agricultural engineering; Machinery development; Tractor; Machine guidance.

1. INTRODUCTION

The area of agricultural machinery can be considered as a sector which significantly effects the efficiency of agrotechnical, agrobiological and agrochemical processes related to the process of the production of farm products and their processing. Function efficiency of this system being a part of the European agriculture depends upon technical and technological capability of the key factors and also on the ability to respond to external effects of the competitive environment. .

According to [1] in last years many factors have contributed to system of agricultural engineering. Reducing human drudgery, increasing productivity, improving timeliness of agricultural operations, and reducing peak labour demands are among the most compelling. The development of new techniques by research facilities and of new machinery by the industries is the driving force for the transfer of technology [2]. Agriculture is currently seeing the introduction of more advanced machinery (i.e., semi-autonomus machines) as well as information technologies (e.g., telematics, on-line remote diagnostic tools-, web-based monitoring and decision making tools) which enable the adoption of the analogous fleet management tools as seen in the industrial domain. However, the inherent dynamic nature of the bio-production systems together with an experienced smaller general user acceptance in terms of formalised planning tools have proven to inhibit the direct integration of current fleet management systems into the agricultural domain [3]. From the point of adaption of new technologies and new machines it is very important to define the trends effecting the development in the sector of agricultural engineering and to identify the most drivers which are powering the trends.

2. METHODS AND MATERIALS USED FOR RESEARCH

In order to analyze the trends in development of the sector of agricultural engineering we conducted the study containing the following steps:

2.1. Definition of the main drivers affecting the development of sector of agricultural engineering

As main driver there was considered the EU Common Agricultural Policy, its goals and principles and its implementation to the Vision 2020 and Strategic Research Agenda of the European Agricultural Machinery Industry. Based on general principles the trends in development of agricultural machines were characterised.

2.2. Characterization of trends in machinery development (case of John Deere 7R Series Tractors)

As the tractor is considered as a basic machine used in agricultural production the case new John Deere 7R Series Tractors was used to present the latest advances and improvements. The new John Deere 7R Series Tractors were characterised from the point of engine power, tractor versatility, operator comfort and implementation of the intelligent solutions allowing to increase the fuel efficiency, performance and productivity.

2.3. Characterisation of the effect of using of field machine guidance system

Field machine guidance system used on the tractor-machine during field operation allows to reduce overlaps and skips and in such a way to increase the efficiency of field operation. Based on this assumption the field experiments were conducted. The following methodology was used:

- selection of the field and determination of the field shape and size by using of autonomous GPS navigation system Leica. The experiment have been conducted on the field of Cooperative farm Vráble.

- selection of fields operation: autumn stubble loosening.

- determination of the appropriate tractor and machine: tractor John Deere 7820 (nominal engine power 136 kW, 6-cylinder turbocharged 6,8 lt engine), stubble disc harrow Kuhn Discover XM 40, working width 5,55 m, depth of soil loosening 0,22 m, working forward speed 12,0 km.h^{-1}. The tractor John Deere 7820 was equipped with satellite guidance system John Deere AutoTrack Universal using StarFire 2 satellite signal. During the field experiments the accuracy of machine passes were recorded. The manual guidance was compared with the accuracy obtained with the using of GPS satellite guidance. The deviation of the machine pass from the ideal line was measured. The results obtained were processed by software tool STATISTICA, version 7.0. Box-Whiskers plot diagrams were prepared allowing to express such values like the median, non-outlier range, outliers, and extremes. The aim was to visualise the results characterising the accuracy of the given guidance systems.

3. RESULTS AND ACHIEVEMENTS

3.1. Main drivers affecting the development of sector of agricultural engineering

The sector of agricultural engineering is an integral part of agriculture. In a first step we need to specifically describe the nature and function of the sector of agricultural engineering.

Agricultural engineering is the branch of engineering that applies knowledge of biological science engineering science and technology to agricultural production and processing. Agricultural engineering combines the disciplines of mechanical, civil, electrical, chemical engineering with animal and plant biology. Basically there are four major specializations in agricultural engineering:

- farm machinery and power engineering,
- irrigation and drainage engineering,
- post harvest process and food engineering,
- soil and water conservation engineering.

Agricultural engineering has been accepted as one of the major disciplines which contribute significantly in increasing the productivity of agriculture in the country by way of increasing efficiency of inputs, conservation of resources and reducing post harvest losses besides value addition of agro-produce.

Functioning of the sector of agricultural engineering is substantially determined by the general agricultural policy implemented in the resort of agriculture. Agricultural policy in the Slovak Republic is heavily influenced by the EU Common Agricultural Policy and its goals and principles:

- to maintain and to strengthen the competitiveness of farming sector and food industry in the national and international markets,

- to provide health harmlessness and to increase quality of food in the interest of healthy public nutrition,

- to support agriculture in its role of protection and preservation of natural sources (especially soil and water) and to preserve bio diversity,

- to preserve use of land for agricultural purposes in areas with unfavourable production conditions, so that this process plays a landscaping, environmental and social role,

- to create conditions for permanent viability of rural areas.

EU Common Agricultural Policy can be considered as main driver effecting the function the sector of agricultural engineering and its development.

Principles of the EU Common Agricultural Policy are implemented also into the development of the European agricultural machinery industry. Under the umbrella of the European Technology Platform MANUFUTURE the community of agricultural engineering in Europe has formulated, for the very first time, a common vision of how agriculture and its driving engineering technologies could look in 2020 and of the strategic technological necessities to translate this vision into reality.

In the year 2006 there was elaborated The Vision 2020 and Strategic Research Agenda of the European Agricultural Machinery Industry [4]. Within this document there is clearly stated that the European agricultural machinery sector is a world leader in supplying enabling technology to the various businesses of crop and livestock farming. With this, the sector of agricultural engineering and technologies is part of the value-added chain for food production as well as for the increasingly important production of bio-materials and energy crops.

The implementation of the new technologies in the sector agricultural engineering will be effected by the rapid increase of the population, by global climate changes, by increased production and use of biofuels and growing demand for renewable raw materials. Due to this trends to the design of agricultural machines there will be significantly implemented the following systems:

- automation by using of GPS guidance and control systems for wide range of machines (section control and application rate control in case of planters, sprayers, etc.), headland management,

- implementation of the robotic systems on the autonomous vehicles used in the area of fertilizing, seeding, weeding and spraying with support of sophisticated sensors,

- electrification of the agricultural machines and vehicles with aim to obtain higher level of the fuel efficiency, automation and provide more efficient drive control.

The main purpose of implementing the above principles is to achieve:

- knowledge-based competitive machinery and process technology,

- food production with documented quality in conformity with the principles of traceability,

- production processes that are fully compatible with environment and animal welfare regulations,

- technology for production and utilization of renewable resources and efficient use of by-products,

- efficient machines to operate in optimized production systems (for example more automated tractors and harvesters, equipped with plug-and-play electronically-controlled,

- implements, networked or autonomous or semi-autonomous, guided via telematic links with a control station).

Overall the EU goal is to improve competitiveness and sustainability by enabling growth based on research and innovation. As a partial goals can be considered:

- reducing of production cost,

- increasing of the competitiveness,
- enhancing product and process quality,
- reducing emissions from the soil during tillage and emissions produced in livestock production,
- increasing of the product safety and traceability,
- improving of the working conditions for machine operators and other staff.

The Lisbon goal of creating a European knowledge-based society through collaborative knowledge generation, advanced training and superior education sets a challenge to the research education and industry sectors associated with agricultural engineering to define and deliver on priorities.

3.2. Characterization of trends in machinery development (case of John Deere 7R Series Tractors)

Tractor is considered as a most important machine used in the agriculture. I order to characterize the development of the tractor design we have decided to demonstrate the tractor development on the case of tractors manufactured by company John Deere. John Deere is the world's top manufacturer of agricultural and forestry equipment, and a leading supplier in lawn care, construction equipment, heavy equipment engines, and the supporting financial services. The company remains on the forefront of technology for the industry, and John Deere products consistently receive worldwide recognition for innovation in performance and design.

For the 2011-2012 season with a focus on increased power, versatility, capacity and improved operator comfort the company John Deere has introduced 7R Series Tractors (5 row-crop models from 150 to 205 kW equipped with the PowerTech™ PSX 6,8 lt or 9,0 lt engine. These completely new row-crop tractor models have many of the performance features found in the larger 8R Series, making them even more productive in the field.

The 7R Series Tractors come with a wide array of new customer-driven features including the new IVT and Command Quad™ transmissions, options for larger tires, compact chassis, and greater engine horsepower ratings. These features give the 7R Tractors the versatility to handle the tillage, planting, haying, loader work and many other tough chores on the farm.

The 7R Series tractors are designed for the producer who needs a more versatile tractor that has more horsepower, more fuel capacity, and greater hitch-lift capacity in order to handle larger implements and be more productive in the field. At the same time, there were integrated a new Interim Tier 4 PowerTech engine with a Exhaust Gas Recirculation system, a fully automatic Infinitely Variable Transmission and other modern technologies into these tractors to deliver improved fuel efficiency.

The 7R tractors have 30 % more fuel capacity and 23 % greater hitch-lift capacity compared to their large-frame 7030 series predecessors. In addition, this new series has an optional integrated front hitch and PTO so producers can easily operate front-driven equipment such as triple-mounted mower-conditioners, snow blowers and a wide range of other attachments. For rear-driven equipment, a new 3-speed economy PTO with power-assist PTO shifting is an available fuel-saving option.

Inside the cab, John Deere has made major changes to enhance the operating experience. Along with a roomier CommandView™ II Cab that gives the operator improved visibility to the drawbar, the 7R Series Tractors have an optional touch-screen video capable CommandCenter™ Display.

The 7R models also can be equipped with ActiveCommand Steering™ (ACS), which utilizes breakthroughs in steering technology to deliver the ultimate in precise steering control, especially at transport speeds. Another available option is an adaptive hydraulic cab suspension system that reads multiple tractor inputs to automatically adjust the suspension for an improved ride.

3.3. Analysis of the effect of using of satellite guidance system for navigation of field machine during stubble cultivation

Satellite guidance systems are generally considered as an effective tools allowing to increase the accuracy of the field machine passes and subsequently to obtain a significant benefits (reducing skips and overlaps of the working widths, reducing fuel consumption and other inputs, etc.). According to chosen methodology we have conducted the field experiments allowing to express the accuracy of machine passes during stubble harrowing.

From the Fig. 1 it can be seen that the using of satellite guidance system AutoTrac with the satellite signal SF 2 mounted in the tractor John Deere 7820, has allowed to obtain higher accuracy of the machine passes during stubble harrowing.

Positive values of the measured deviation are equal to overlaps of the harrow working width and negative values are equal to skips (non-cultivated area). The results obtained have confirmed that the using of satellite guidance system John Deere AutoTrac allows to provide given field operation (stubble harrowing) much more accurate. According to [5] higher accuracy of the field operation allows to reach significant economical benefits. Such results fully corresponds with the general trends outlined for the sector of agricultural engineering.

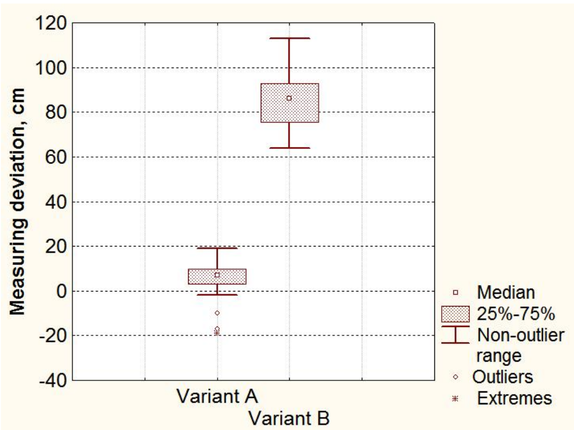

Fig. 1. Box-whisker plot diagram characterising the accuracy of the AutoTrack satellite guidance (Variant A) and manual guidance (Variant B), stubble harrowing, tractor John Deere 7820+ stubble disc harrow Kuhn Discover XM 40

4. CONCLUSIONS

Sector of agricultural engineering as part of resort of agriculture can be considered as an industry that develops dynamically. This development can be observed in the construction and design of machines, where are used many new and innovative solutions to achieve higher productivity, lower costs, greater comfort for the operator, but also beneficial effects on the environment. As a result of implementing new intelligent solutions in the design of machines there is an increasing demand for knowledge and skills not only operators but also production managers who are responsible for the management agricultural machinery within the production systems on the farm. These changes should be respected and taken into account when preparing new study subjects and new study programmes.

5. ACKNOWLEDGEMENTS

The paper reflects the results obtained within the research project VEGA No. 1/0082/09 „Research of the effects of soil tillage technologies and machines with regard to the CO_2 emissions from soil to the atmosphere“ and project NFP No. 26220220014, „Application of the information technologies to increase the environmental and economical sustainability of the production agrosystem (Activity 3.1 Creation of the department of transfer of technology to the practice)“, (OPVaV–2008/2.2/01-SORO).

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The industrial enterprises performance optimization by the application of competency models

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Abstract

Contemporary conditions for operating industrial enterprises are remarkably influenced by wide changes in society, such as political and economic integration, internationalization, business and production globalization, process of ecologization and others. The mentioned conditions, multiplied by a world-wide economic crisis totally evoke new conditions for industrial enterprises. To react properly to the above mentioned changes and maintain sustainable entrepreneurial development it is needed to optimize their performance. In this regard the human factor is crucial element, therefore is needed systematically work with key employees competencies (mostly managerial competencies) in the course of industrial enterprises performance optimalization. The practical output of the competence approach applied in the human resource management in industrial enterprises is exploitation of competence models. The article describes the creation of competence models in industrial enterprises.

Keywords: Management; Performance; Model; Competency; Competitiveness.

1. INTRODUCTION

Contemporary period of turbulent changes in all areas of social life influenced by globalization and world economic crisis create totally new conditions for operating industrial enterprises. Therefore it is necessary to optimise the enterprise performance to properly react and maintain the enterprise sustainable development to react to the above mentioned changes. Looking at long term point of view, the key factor of enterprise performance optimization in the mentioned conditions is to reach the demanded (not maximised) level of employee performance as well as to maintain it.

It is required to systematically manage demanded level of enterprise performance sustainability. Due to the changes of enterprise conditions as well as of the employees' attitude (different values and needs, the necessity to actively engage into the enterprise actions) it is crucial to change the approach to employee management and performance management.

2. THE COMPETENCY APPROACH TO HUMAN RESOURCE MANAGEMENT

One of the possibilities to optimize industrial enterprises performance is the utilization of the competency approach. The competency approach has remarkably influenced all areas of human resources management and has offered new insight into the possibility to improve enterprise performance. [1]

The main requirement for the successful application of the competency approach in industrial enterprises is the application of competency models. Therefore it is essential to identify and precise key competency definition for enterprise managers.

3. KEY MANAGERIAL COMPETENCIES

The term competency is not clearly defined in professional literature because there is missing agreement what the competency is and what does it consist of. It is caused by the fact that the different authors approach to definitions of this term from various points of view. Moreover, from the point of view of intercultural dimensions it is necessary to realize that in various languages the term competency has various meanings.

For research purposes carried out in industrial enterprises in the Slovak Republic in 2010- 2011 and for the needs of creation of an identification procedure for key managerial competencies, we have used the following perception/understanding of the individual term **key managerial competency (KMC)**: a combination of knowledge (a complex of accumulated cognitions), skills (specific abilities to carry out specific activities), attitudes (steady ways of behaviour which are created on the basis of experience) as well as personality characteristics (a complex of intelligence, emotional and physical properties) used by the employee in his/her work and enabling him/her to achieve excellent (the above standard) performance. [2] Such performance exceeds average performance of the defined group of managers at least by the value of one standard deviation.

4. PROCESS OF THE COMPETENCY MODELS CREATION

Following the research of this problem in specific conditions of industrial enterprises operating within Slovakia, it is obvious that the stated subjects do not have enough information on competency approach. This is the reason why many enterprises have not identified the competencies for managerial positions and for that reason they cannot practically utilize competency models. On this account, the focus was placed mainly on the creation of a methodical procedure for the KMC identification. These competencies secure the excellent performance of a manager in particular conditions of a specific enterprise. The main goal was not to create a strict (unified) procedure of identification, but to provide a base methodical frame where all the suggested steps of identification are detailed. These can be adjusted by the enterprise following its own specific conditions. The process of the competency model creation in the particular conditions of industrial enterprises will be influenced by the enterprise culture and the intention to utilize the identified competencies. The competency model should consist of those competencies that are necessary to reach the excellent performance of a manager at a particular position. The suggested procedure consists of 10 steps (phases) presented in Fig.1.

The whole process of the competency model creation needs to come out of the **overall strategy and the personnel strategy of the enterprise** (0 phase), so that the competencies can be identified and lead to meeting the enterprise strategy as well as reaching the long term goals of the enterprise.

The first step of this process is the phase of **planning the KMC identification process** (1st phase). This phase is a critical aspect because it leads to definition of all determining questions of identification and it presents a base for a successful application of identified KMC into practice. Within this step it is necessary to define the goals of identification, gain the support on the part of management, particularly those who will be involved in the identification. Moreover, it is necessary to create a team for the KMC identification process and to set the communication plan.

The next step of KMC identification is **to set the performance criteria** (2nd phase) that would be instrumental to define the effective performance measure on managerial positions. Within this step, it is necessary to set the criteria of performance for managerial positions that will include reliable data reflecting the enterprise's performance management, so-called hard criteria (sale, profit, productivity, if they exist for the given work place), but also for so-called soft criteria (criteria of the manager's behaviour-willingness to assume risk, flexibility, cooperation, relationships with the colleagues,...).

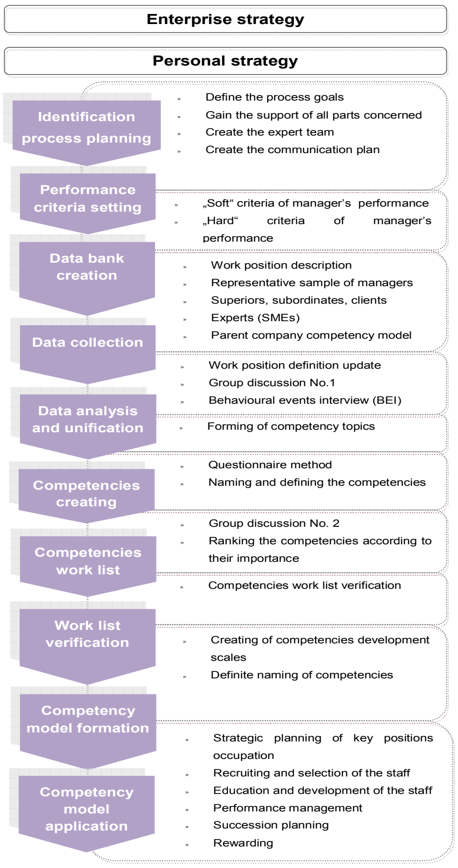

Fig. 1. Competency model creation process [2]

In the third phase of this procedure, it is necessary **to create a kind of data bank** that will be instrumental to gain the information necessary to identify KMC in the particular enterprise. The data bank may contain e.g. the working position description, a representative sample of managers, relevant employees, clients, and experts (SMEs - subject matter expert), a parent company competency model and so on. Inserting and utilising the individual data sources will be dependent on the defined goals of KMC identification and on the managerial positions for which the competencies will be identified by the enterprise. Data source options will be influenced by financial and time sources selected for the whole process.

While identifying the KMC, there should be at least two **data collection** methods used (4th phase). If the data collected by one method is similar to the data collected by a different method, there is greater credibility and certainty that the KMC will be identified exactly. According to experts in the field of the competency approach, the most suitable methods to reveal managerial competencies are: a structural interview (BEI, RGI), panel and questionnaire methods [3], [4].

In the fifth phase, the **data** gained by means of the data collection method will be **analysed** so the behaviours could be identified, particularly those that differentiate excellent managers from average ones. The results of this step will present grouped related behaviour occurrences that will form the basis for outlining KMC.

In the sixth phase, the expert team will rework these grouped behaviours and **create definitions of competencies** so that they can describe as exactly as possible the behaviour which each given competency characterises.

In the next phase (7th), **the list of competencies** important for managerial positions will be formulated using the competency glossary, with the help of discussion group No. 2. The goal of this discussion group will be the creation of a list of competencies that differentiates the excellent managers from the average ones and ranks them according to importance concerning the excellent performance reaching a given position.

KMC list proposal should be **verified** by experts from the given field (8th phase). The authors recommend to use the questionnaire form for this verification. The output of this step will be presented as a list of KMC ranked according to their importance to reach excellent performance and they will form the base for creating the competency model.

For each managerial competency, there should be examples of behaviour created on different levels (9th phase). At the end of this step, the competency will be definitely named. Creating of behaviour descriptions is recommended in the form of evaluating levels of development for each KMC. Firstly, the negative behaviour utterances will be described within the competency and consequently, the utterances that show evidence of high level of the competency development. The highest & lowest level of given competency development will be defined. Title should present the short and total utterance of behaviour forming the core of the competency [3].

The value of the identified KMC consists in their application to the personnel processes of a particular industrial enterprise. This value is maximized if the competencies are implemented within all personnel processes. For this reason, the last step of KMC identification (10th phase) is presented by **application of the created competency model into personnel processes.** This model describes the way to implement the competency model into the personnel processes on the basis of the stated methodology. Personnel processes are the following: strategic planning of the key position occupations, recruiting and selection of the staff, education and development of the staff, performance management, succession planning, and employees' rewarding.

To make the created competency model a real tool of industrial enterprise performance increase, the key competency list needs to be updated according to the enterprise strategy and the other key factors of changes. In conclusion of the whole KMC identification process, the expert team needs to set the schedule of the competency model examination. In case there are no distinctive changes in the given enterprise, group discussions or questionnaires may be used to update. If the managerial positions change markedly, or expressive changes come into being within the enterprise, it is necessary to perform a new process of KMC identification.

5. CONCLUSION

The main goal for the development of the competency model creation process in industrial enterprises was to set the conditions for long term achievement of the enterprise performance required. Demand for creating such a procedure also came from the finding that industrial enterprises in Slovakia do not have enough information on the competency approach and its contribution. At the same time, nearly half of the enterprises participating in the above mentioned research displayed interest in creating of competency models. The suggested recommendations form a methodical frame to the competency model creation that could be adjusted by every enterprise according to its own specific conditions. Successful application of this procedure can help the stated subjects to succeed in the competitive struggle and, at the same time, reach long term sustainable development through their own employees.

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Fatigue behaviour of steel sheets treated by nitrooxidation

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Abstract

Low carbon deep drawing steel DC 01 according to EN 10130-91 was nitrooxidized in dissociated ammonia at 580°C/45 min and consequently oxidised at 380°C/5 min in vapour of distilled water. Material after nitrooxidation had 54 % increase of yield point, 34 % increase of tensile strength and acquired 10th level of resistance to atmospheric corrosion in comparison to the material before nitrooxidation. The microstructure of treated material consisted of thin ε-phase layer connected to layer containing precipitated massive needle shaped Fe_4N - γ' nitrides. This layer passed to a diffusion layer consisting of fine irregular shaped $Fe_{16}N_2$ - α'' nitrides regularly dispersed in ferritic matrix. Fatigue properties were examined under bending load with frequency of 20 kHz and sinusoidal symmetric cycle. The results confirmed positive influence of nitrooxidation on fatigue properties as fatigue limit of treated material was double in comparison to untreated material.

Keywords: Nitrooxidation; Fatigue; S-N diagram.

1. INTRODUCTION

Nitrooxidation is a method of steel sheets surface treatment, which significantly increases their corrosion resistance together with increase of the mechanical properties [1,2,3]. It consists of surface nitridation with subsequent oxidation.

The fatigue degradation process and the initiation of the fractures are in close connection to the surface, likewise the subsurface properties of the steel sheet. The priority of surface or subsurface fracture initiation with regard to the number of cycles is often discussed.

The previous research activity [4] dealt with the welding possibility as well as forming properties of this type of treated steel sheets. Because of potential practical applications, further attention was focused on fatigue behaviour [5]. This paper deals with the comparison of fatigue behaviour of nitrooxidated steel sheet DC 01 EN 10130-9 to the identical material without surface treatment.

2. MATERIALS AND METHODS USED FOR RESEARCH

The material used for the experiments was thin steel sheet DC 01/DIN EN 10130-9 of 1 mm in thickness. Chemical composition is shown in Table 1. The material was nitrooxidized in fluidized bed, which was performed in Kaliareň, PLC in Považská Bystrica. The nitridation fluid environment consisted of Al_2O_3 grains of 120 μm in diameter wafted by gaseous ammonia. After the nitridation, oxidation process started subsequently. Oxidation itself was carried out in vapours of distilled water. Nitrooxidation parameters are presented in Table 2.

Table 1. Chemical composition of steel DC 01

C [%]	Mn [%]	P [%]	S [%]
max. 0.10	max. 0.45	max. 0.03	max. 0.03

Table 2. Parameters of nitrooxidation

Nitriding temperature [°C]	Nitriding time [min.]	Oxiding temperature [°C]	Oxiding time [min.]
540	45	380	5

Experimental activity was carried out at the Faculty of Mechanical Engineering at the University of Žilina. As a testing device, ultrasonic fatigue machine KAUP-ŽU (see Fig. 1), consisted of piezoceramic transformer, conic stress concentrator, ultrasonic generator and specimen, was used. The fatigue experiments were carried out in condition of bending loads with frequency of 20 kHz. All specimen were tested to the failure point.

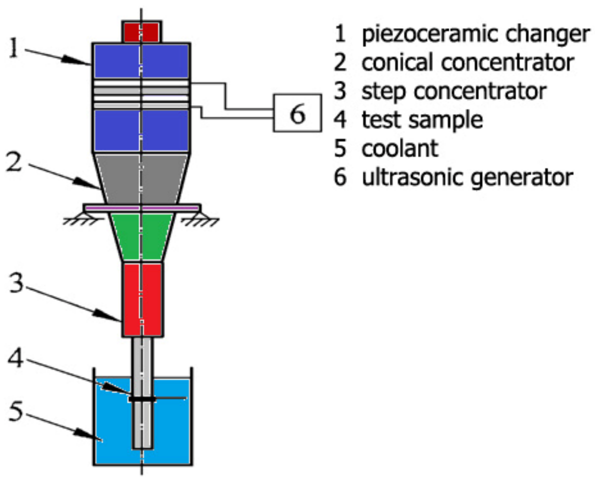

Fig. 1. KAUP-ŽU ultrasonic testing device

The dimensions of the specimens (see Fig. 2) were designed in regard to high-frequency load requirements. All tests were performed at the room temperature (20 °C).

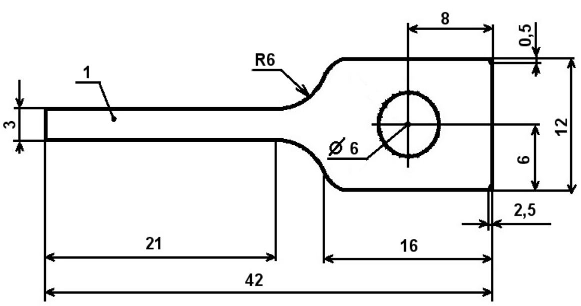

Fig. 2. The dimensions of fatigue test sample

The analysis of the fatigue fracture character was observed by the fractographic analysis of the fractured surfaces.

3. RESULTS AND ACHIEVEMENTS

The results of high-frequency fatigue tests, presented in S-N diagram, are shown in Fig. 3. The measurements were performed in the interval of the stress amplitude σ_a = (260 ÷ 80) MPa, which represented the $N_f \approx 8 \times 10^5$ to $N \approx 2 \times 10^8$ cycles to failure. In the graph, it is compared the fatigue characteristics before and after the process of nitrooxidation.

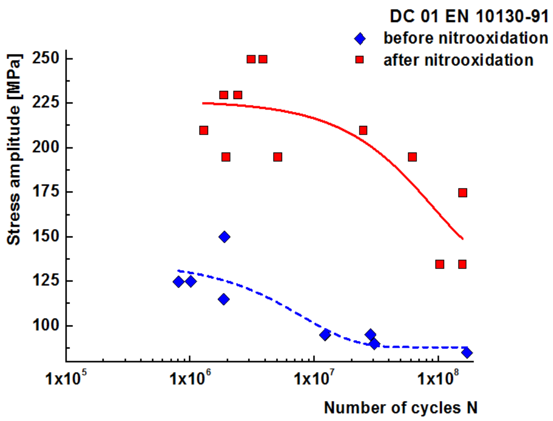

Fig. 3. The results of fatigue tests

In the case of both series of specimens, the continuous drop of the fatigue life from the high-cycles fatigue to ultrahigh-cycles fatigue was observed. This decreasing fatigue life lead to increase of the number of the cycles to failure (i.e. increase of the fatigue life). The fatigue life of the material without nitrooxidation was significantly less in comparison to nitrooxidized material.

The results of fractographic analysis showed, that in the material without nitrooxidation, fracture propagation was observed in both of the steel sheet sides. Compared to that, the fracture initiation and propagation in the case of nitrooxidized material was mostly multiple (Fig. 4). The fatigue cracks were principally propagated from the corner sides of the steel sheet (Fig. 5).

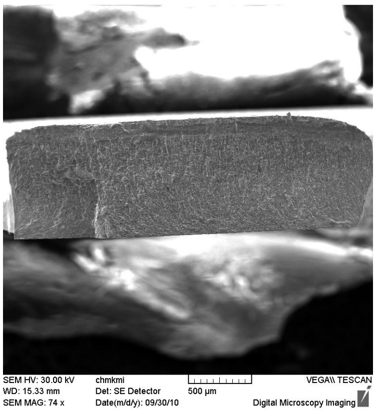

Fig. 4. Fatigue fracture look of the nitrooxidized material

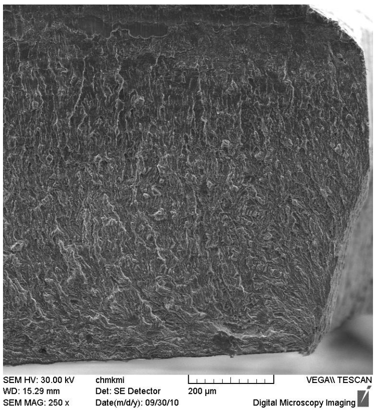

Fig. 5. Fracture initiation from the corner side of the nitrooidized steel sheet

During the fracture initiation as well as in the final fracture, the damage of the brittle oxide surface layer was observed in the material treated by nitrooxidation (Fig. 6).

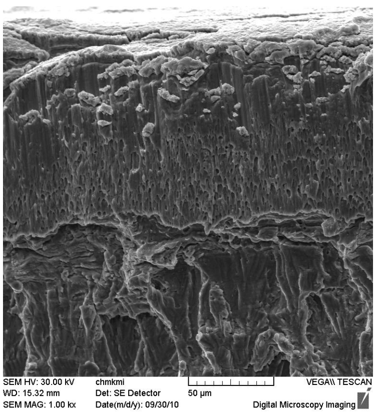

Fig. 6. Oxide layer damage in the area of final fracture

4. CONCLUSION

Based on the results, it can be stated, that the process of nitrooxidation has a positive influence on fatigue life of the thin steel sheets. The fatigue strength of the nitrooxidized material was two times higher compared to material without nitrooxidation. Based on the fractographic analysis, it can be concluded that the nitrooxidic layer particularly prolonged the fatigue initiation period and therefore the overall fatigue life of this type of treated steel sheets was extended as well.

5. ACKNOWLEDGEMENTS

This paper was realised within the support of Slovak Research and Development Agency, grant No. 0057-07 and Scientific Grant Agency VEGA, grant No. 1/0203/11.

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Effect of cutting environment on milled parts surface

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Abstract

This article deals with a characteristics of cutting environment and their impact on the quality of the surface when milling. In the first section is summarized the basic knowledge of cutting environments, the cutting characteristics of the environment, cutting distribution environment and their characteristics, as well as the choice of cutting environment for the method of milling. Another section is devoted to the uncertainties arising during operation, achieved a qualitative parameter for milling. This particularly affects the surface quality, dimensions and deviations arise, which are compared with tolerances according to ISO standards. Experimental section was devoted to the choice of machining parameters, model design and the manufacture of parts on universal CNC five axis high speed machining center by using air-cooling and cutting fluid Blasocut BC 25. The last part of this work was to evaluate the experiment, which compared the accuracy (length and angular dimensions) and surface quality (roughness) of milled parts made when cooling air and cutting fluid were used.

Keywords: Cutting environment; Roughness.

1. INTRODUCTION

More and more types of cutting environments and its possibilities are at the market at nowadays. It is necessary to deal with the investigation of their proper use during operation, determine the optimum cutting conditions, parameters and maximize the quality of the workpiece. Traditionally, cutting fluids have been seen as a solution rather than a problem in metal cutting. They have proven to be a significant benefit to the metal cutting process and do have an important role in improving and maintaining surface finish, cutting force reduction, size control, dust suppression, and corrosion resistance [1]. Adverse effects of heat and temperature can be reduced by using appropriate cutting environment [2]. Some of these properties can be achieved by using compressed air as cutting environment which is more environmentally friendly.

It is interesting to note that in dry cutting, air itself plays a suitable role. The oxygen in the air has lubricants effects. However, the oxygen accelerates notch wear at the ragged edge of the cut [3]. The aim of the experiment was to determine the effect of cutting environment on macro and micro geometric inaccuracies of part produced by milling.

2. METHODS AND MATERIALS USED FOR RESEARCH

Status of machined surface and thus surface origination during cutting process depends on the method of machining [4]. Each method has its own mechanism of the surface origination. Geometric condition may be determined on machined surface which is defined by macro and micro asperities, waviness, grooves and broken places. The experiment investigated dimensional accuracy of workpiece and measured deviations were compared with the general tolerance presented in ISO 2768 standard. The deviation of shape (roundness, cylindrical) and deviation of direction (tilt) were measured. Surface roughness of parts made using a fluid cooling and air cooling were compared to each other. The measurement was preceded by the following steps: modeling in CAD, creating the

NC program in CAM, manufacturing of parts using CNC machine tool and measurement.

2.1 Preparation of CAD/CAM models

The model consisted of a base (100x100x20mm), individual elements, such as sloped surfaces of different lengths and angles (angle 45°, 25°, 15°) cylindrical surfaces of different diameters and heights (Ø24mm, Ø20mm, Ø16mm), holes (Ø20mm, Ø15mm, Ø10mm) deep eight millimeters and groove (10x50mm) deep ten millimeters (Fig. 1).

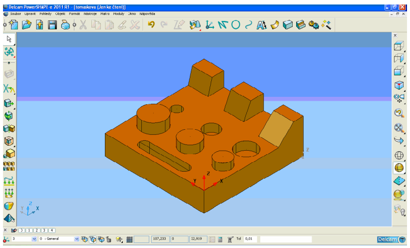


Fig. 1. 3D CAD model in PowerSHAPE

For roughing in PowerMILL Z-heights strategy was used. The tool steps down to a specified Z height and fully clears an area (slice) before stepping down to the next Z height to repeat the process. For finishing vertical surfaces a constant Z strategy was used. Constant Z Finishing creates a toolpath by slicing the model at specific Z heights. This works well on near vertical surfaces which require a consistent depth of cut. For horizontal surface Offset flat finishing was used. Offset toolpath works well at the bottom of pockets whereas raster toolpaths are often used on open parts.

2.2 Condition of experiments

Machined material: steel STN 41 2050

Machine tool: DMG HSC 105linear

Milling tool: For machining 2 roughing and 3 finishing strategies were used. To produce parts, milling shank cutters made by SECO were used.

Cutting conditions for finishing; tool JH 930080R020 – MEGA:

Cutting speed: vc = 310 m/min

Feed: v_f = 4934 mm/min

Cutting conditions for finishing; tool JS 514XL080Z4.0-SIRON-A:

Cutting speed: vc = 163 m/min

Feed/ tooth: fz = 0,072 mm

Cutting environment:

a, emulsion cutting fluid Blascocut BC 25 (5% concentration),

b, compressed air.

3. RESULTS AND ACHIEVEMENTS

Individual measurements of parts produced under different cutting environments were realized as follows. As a first the surface roughness on all parts was measured using surface indicator SURFASCAN S-2A – SOMICRONIC. To measure linear and angular dimensions two methods were used: the first measurement was handmade using various auxiliary instruments and the second one use scanning device ATOS II.

3.1 Measuring the roughness of machined surface

Machined components were individually clamped into the fixture device (vice) on the workbench and measurement of the roughness in marked positions on parts was realized (Fig. 2).

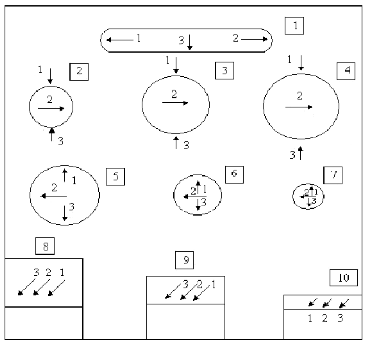
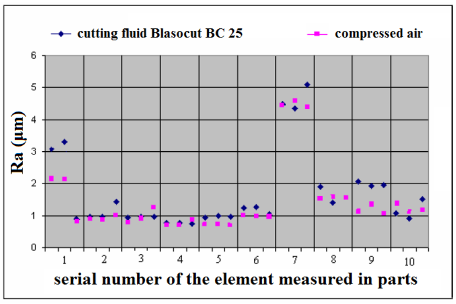
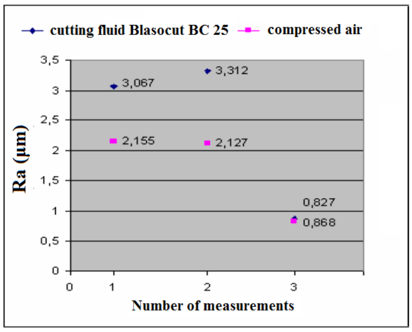


Fig. 2. Positions for roughness measurement

The graphical interpretation of roughness (Dgm. 1) shows, that the measured object number 1 (groove) has worse surface roughness in cooling fluid than in air (Dgm. 2). Inconvenient surface roughness Ra was achieved on the object number seven (hole Ø10mm).



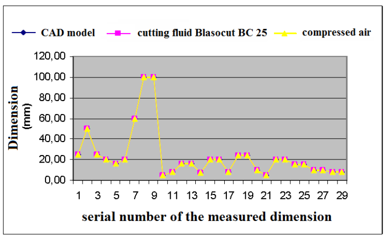
Dgm. 1. Values of surface roughness on the position of the element



Dgm. 2. Surface roughness Ra for element num. one

3.2 Measuring of linear and angular dimensions

To measure the parts; manual measurement of lengths and angles and the ATOS II scanning measurement were used. The aim was to determine if using of two cutting environments under constant cutting conditions will achieve required dimensions and tolerances.



Dgm. 3. Deviations in measuring linear dimensions

On the model created in cutting fluid environment no significant deviations from the general tolerance were achieved (Dgm. 3). Many dimensions measured on the model created in cutting fluid environment reached worthy of a zero deviation from the CAD model. It can be concluded that using of cutting fluid environment is more preferable for more accurate evaluation of a model as cooling by compressed air.

3.3 Scanning models ATOS II scanner

ATOS is an industrial, high resolution, optical 3D scanner [5]. Using the digitizing system ATOS, objects can be measured quickly and with high local resolution. The system is based on the triangulation principle. Scanned part was marked with encoded reference points (Ø1,5 mm). After scanning the 3D model of part was imported into the ATOS Profesional V7 SRA 3D software as well as the model created in CAD. Importing of the model was necessary for compensation of scanned and CAD created 3D model of a part using the method of **best fit**. Then a color map of deviations between CAD model and scanned data was created (Fig.3, Fig.4).

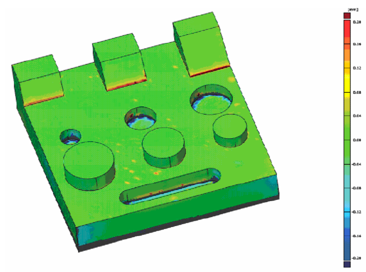


Fig. 3. The color map of deviations of CAD model and the model produced with liquid coolant

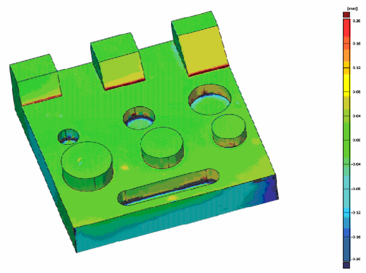


Fig. 4. Color map of deviations of CAD model and the model produced with cooling air

The largest deviations from the original model are clearly visible between tilted surface and basement of the workpiece (red color). These deviations arised due to a fact that the tool has a corner radius (rε1). It could be eliminated by additional machining. Evaluation of 69 measurements of length and angle dimensions prove, that only one tilted surface´s deviation was greater than allowed general tolerance. Allowed general tolerance was overran in the air cooling environment. Also roundness and cylindricity was measured on both parts produced in two cutting environment. Evaluation of roundness was based on values obtained from ATOS II 3D model and its comparison with CAD model. Parts produced in cooling fluid environment with 5% concentration of cutting fluid Blasocut BC 25, achieved small deviations of roundness. On the other part, produced in cooling air environment, the roundness deviation values were significantly higher. Therefore, cooling air environment is in this case less appropriate. The deviations may not have been affected only by selected cutting environment. There are many other adverse factors that occur the machining process. A similar conclusion can be observed also in cylindricity measurement.

4. CONCLUSIONS

Measured values are affected by many factors mainly the change of cutting conditions. Therefore, the experiment used same conditions for both parts, only cutting environment was changed. Measured differences were not significant and could not be clearly claimed that selected cutting environment has affected measured values. For this condition of experiment (type of tool, cutting conditions, tool path) cutting fluid environment was better.

Too many factors are affecting the cutting process. If we want to find out which of them could affect the quality of part, we should continue, for example with measurement of tool wear; chips generated in machining and many others influences.

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Cutting fluid's pressure influence on surface quality in Rotary Ultrasonic Machining

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Abstract

Submitted article deals with cutting fluid influence on surface quality in rotary ultrasonic machining. Technology of rotary ultrasonic machining is a nonconventional technology using axial tool vibration with ultrasonic frequencies in order to machine hard and brittle materials. It differs from original ultrasonic machining in following ways: the tool is rotating instead of vibrations and cutting fluid does not includes any abrasive particles - abrasive particles are fixed on the tool. Hence the cutting fluid used in this technology is similar to a cutting fluid used in conventional milling or grinding technology as well as the function of the fluid is similar. In differ of conventional machining process mentioned before, in ultrasonic machining the main function of cutting fluid is to carry out the chips from cutting zone, not the heat reduction. In order of chips unloading speed and efficiency, cutting fluid pressure is important parameter. In submitted article an experiment is described when the pressure was changing from 10 to 30 bar both for drilling and milling with ultrasound. Evaluation of experimental parts was based upon surface roughness and edge chipping effect. Experiment provides results which were corresponding with theoretical presumption in cutting fluid pressure effect on edge chipping however, results of surface roughness brought to us new knowledge which stand a new topic for research in the next work.

Keywords: Pressure; Surface quality; Edge chipping.

1. INTRODUCTION

In machining, disregarding technology, surface quality of a workpiece is the main parameter of production quality. Many technologies today guarantees very good surface quality, evaluated in Ra with values of at least 0,5 μm and better. The better results among others we can achieve from rotary ultrasonic machining, according to a theoretical knowledge, a values of Ra = 0.2μm [1]. Rotary Ultrasonic Machining is a technology raised from Ultrasonic Machining, where the tool beside rotation also vibrate. The vibration allows diamond tool to machine hard and brittle materials according to a cutting forces' values declination. However, once hard and brittle materials are machined, mechanical abrasion by localized direct hammering of the abrasive grains of the diamond coated tool is the main material removal process. Hence Edge chipping occurs in Rotary Ultrasonic Machining. Edge chipping is a breaking of the edge of the material when a through hole is machining. This effect is typical for hard and brittle materials due to its material properties. For these materials brittle failure is typical for material removal mechanism. When the tool is coming through the workpiece, the edge of created hole breaks. This effect is called edge chipping [1].

One of the most important fact in Rotary Ultrasonic Machining is cutting fluid must be used in machining. Cutting fluid is used for chips removal and it is necessary to use it in order to achieve desired surface quality. The task is how much the cutting fluid's pressure is influencing the surface quality consequently Edge chipping in ultrasonic milling a hole compared to drilling.

2. METHODS AND MATERIALS USED FOR RESEARCH

Theoretical presumption was as following: the surface quality of milling should be worse of drilling due to different tool paths, however the Edge chipping rate should be vice versa according to a pressure. In order of verification of this statement two experimental parts were machined.

2.1 Experiment conditions

For experiment two silica glass plates were used. Size of experimental parts was 100x60x10 mm. Into the parts a set of through holes was machined according to a scheme in Fig.1, one by drilling one by milling. Three holes with each pressure were machined to avoid mistakes.

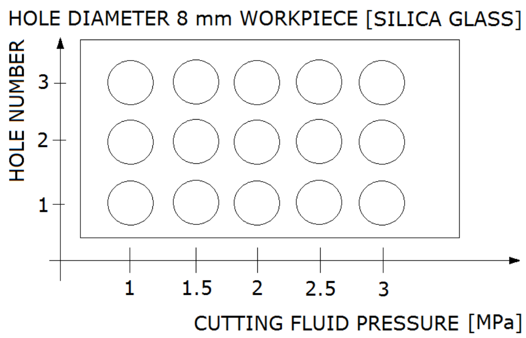

Fig. 1. Scheme of experimental parts

Cutting fluid Zubora TXS from Zeller+Gmelin was used in experiment with characteristics showed in Tab.1.

Table 1. Cutting fluid parameters

Parameter	Value*
pH	9.1
Viscosity[3]	300 m/s
Consistency[3]	1120 kg/m³
Corrosion d.[3]	0
Concentration	5%
Pressure values	1; 1,5; 2; 2,5, 3 MPa.

*[*all values are valid for temperature 20°C]*

Both outer and inner [through the tool] cooling was used with same pressure.

For experiment a DMG Sauer Ultrasonic 20 linear machine tool was used and two diamond tools were selected.

2.2 Cutting conditions

For drilling a diamond hollow drill was used, for milling a diamond shank cutter was used with downwards spiral path. Tools' parameters and cutting conditions for each tool are in Tab.2, machining principle is shown in Fig.3.

Table 2. Tool parameters and cutting conditions

Parameter	Drill	Cutter
Length	40 mm	40 mm
Length	15 mm	15 mm
Diameter	8 mm	4 mm
Wall thickness	0.5 mm	1.5 mm
Cutting conditions		
Rotation speed	4000 min^{-1}	4000 min^{-1}
Feed	5 mm.min^{-1}	50mm.min^{-1}
Cutting speed	100m.min^{-1}	50 m.min^{-1}
Frequency	23530 Hz	25840 Hz

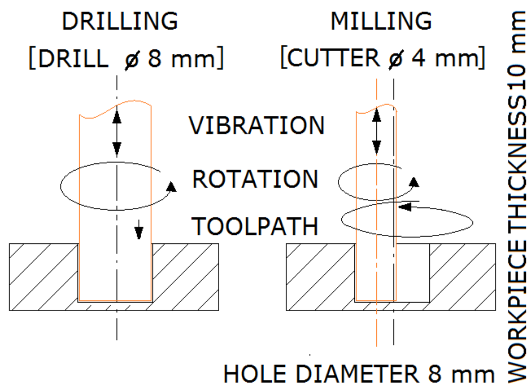

Fig. 2. Machining principle

Cutting fluid pressure was changed discreetly according to values stated in Tab.1 in the same way for drilling and milling according to a Fig.1

3. RESULTS AND ACHIEVEMENTS

Two surface quality parameters were evaluated on experimental parts: surface roughness of inner cylindrical surface of a hole and edge chipping rate.

3.1. Edge chipping evaluation

For Edge chipping rate evaluation an optical method was used. Each hole was divided into 4 quadrants according to a scheme in Fig.3 in order to measure at least 4 values of edge chipping on each hole to rise up accuracy of measurement. A mean value was later calculated for each hole. For measurement a Zoller Genius 3 measurement device was used (Fig.4).

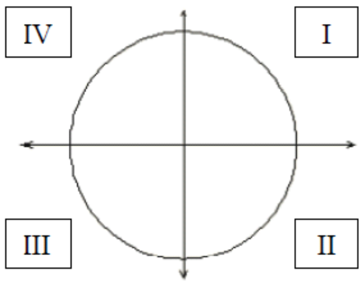

Fig.3. Division of a hole into quadrants

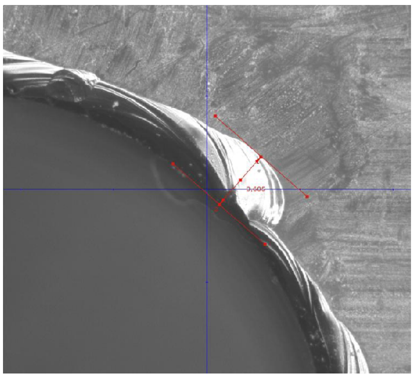

Fig. 4. Edge chipping measurement

Measured values of edge chipping for drilling and milling are in Tab.3 and Chart 1.

Table 3. Edge chipping rate measured values

Pressure [MPa]	Edge chipping rate [mm]	
	Drilling	Milling
1	0,82	1,265
1,5	1,242	1,214
2	1,521	1,126
2,5	1,898	0,988
3	2,085	1,531

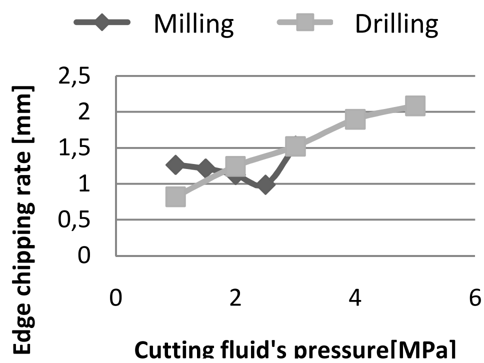

Chart 1. Edge chipping dependence on cutting fluid's pressure

Measured values show predicted results. Rising of cutting fluid's pressure caused higher Edge chipping rate. However this is valid only for drilling, Edge chipping rate in milling seems to be not depending on cutting fluid's pressure. The reasons are written in conclusion.

3.2 Surface roughness evaluation

Surface roughness was evaluated by Ra value. For measurement a Surtonic surface roughness measurement device was used (Fig.5).Measured values are in Chart 2.

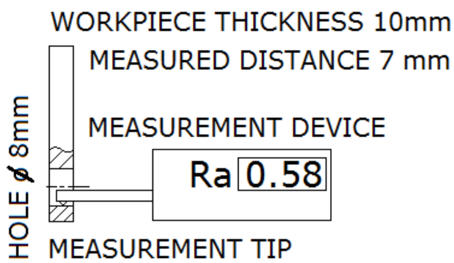

Fig. 5. Roughness measurement principle

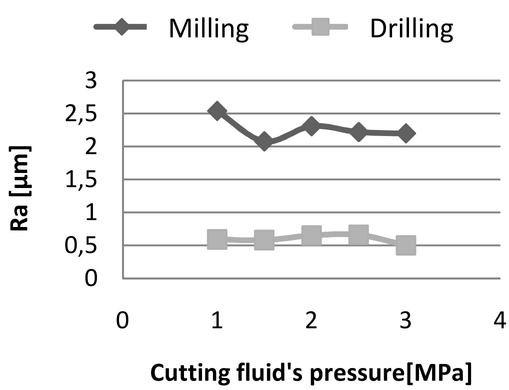

Chart 2. Ra value dependence on cutting fluid's pressure

4. CONCLUSIONS

Results from measurements summarized in chapter 3 provides some expected and some unexpected interesting results. Results are concluded in the next.

1. Edge chipping in drilling earns expected results. With rising of the pressure, edge chipping rate values are also rising (Chart 1). This can be explained as follows: when a hollow drill was sinking into the silica glass, the pressure was affecting the material. Since the tool was deeper in the work piece, the material thickness was lower. At a critical rate of material thickness according to actual pressure the material broke down and edge chipping occurs. Edge chipping in drilling was uniform on hole's perimeter due to a tool's diameter of 8 mm (same as hole) and the linear downward tool path. In drilling cutting fluid's pressure has significant effect on edge chipping.

2. Edge chipping in milling earned different results (Chart 1). The dependency of edge chipping on cutting fluid's pressure is not so clear. This is caused by following facts: The diameter of tool was 4 mm with wall thickness of 1.5mm. Hence the pressure of a cutting fluid was not affecting whole bottom of the hole, like in drilling, but only a small surface of a diameter of 1mm. Therefore the critical rate of material thickness was dramatically lower than in drilling. The path of the tool was not linear downward, but spiral downward and therefore the edge chipping is not uniform on hole's perimeter, however for more reliable results of measurement of edge chipping in milling a volumetric method should be more suitable.

The volumetric method as well as the critical material thickness will be topics for following research.

3. Surface roughness of inner cylindrical surface of holes brought also unexpected results. The best achieved results has a value of Ra=0.52 µm. In literature it is presented, that by ultrasonic machining a value of Ra = 0.2µm is reachable, however there is not written under which conditions these values were machined and measured. In experiment, tools with 107H diamond grit size were used. It can be supposed, using a smaller grit size will bring better values of Ra, anyway reaching the best surface quality was not the aim of the experiment.

4. From Chart 2 it is clear that values of surface roughness characterized by Ra are not depending significantly on cutting fluid's pressure. This can be explained as follows: although the higher cutting fluid's pressure provides faster chips removal from the cutting zone, the faster chips running out of the process are also more affecting machined surface. Cutting fluid's pressure has no significant effect of machined surface quality characterized by Ra.

5. As was expected, surface quality of inner cylindrical surface of a hole achieved much better results in drilling than in milling. The explanation is as follows: In milling the tool is moving in a spiral path, when in drilling the tool moves downwards along the Z axis. Than the reason is machine's circular interpolation is not so smooth and accurate to provide better values as well as the tool in milling was influenced by cutting forces in X and Y axes whereas in drilling the load was only in Z axis. Cutting forces induces push away of a tool which also results to worse surface quality. In the next research the roundness and cutting forces measurement will be performed in order to verify above-mentioned justification.

Experiment provides cutting fluid's pressure has significant effect on machined surface quality characterized by edge chipping in drilling and not provable effect on surface roughness characterized by Ra.

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Characterization of selected silicone rubbers during vulcanization and loading

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Abstract

The standard measurements of vulcanization curves were carried out on selected samples of silicone rubbers for spin casting at temperature range from 140 to 180 °C. The isothermal measurements of torque moment shown, that incubation period of these rubbers are sensitive on concentration changes and also vulcanization rate is influenced by rubber composition. There are also results of other measurements described in detail in paper.

Keywords: Vulcanization; Silicone; Mould; Centrifugal casting.

1. INTRODUCTION

Currently foundries use different materials for mould production, which have sufficient properties to produce castings, which meet market requirements. These materials include silicone materials used in the manufacture of moulds for centrifugal casting of low melting point alloys. Necessary part of the silicone mould manufacturing is vulcanization. The silicone slowly cures to heat and chemistry resistant mould under controlled temperature and pressure. These moulds allow casting zinc alloys, tin alloys and small volumes of small aluminium castings [1].

Such silicone material is used for Tekcast method and thus can be achieved significant decreasing of production costs and mouldmaking time. The strength and lifetime of these moulds is significantly influenced by vulcanization process [2]. Because of this vulcanization process must be closely studied an characteristics like vulcanisation time and number of created bonds at various vulcanisation temperatures must be observed.

2. VULCANIZATION OF SILICONE MOULD

All silicone materials used by preparing silicone mould need vulcanization before they get their elastomeric properties. This process is made in the hydraulic vulcanizer, where the materials operating pressure and temperature. Vulcanizing temperature and pressure depend on the type of silicone material and dimensions of form.

Special properties of silicone rubbers used by centrifugal casting of materials with low melting point are unique in that they carry both inorganic and organic properties in terms of molecular structure unlike ordinary organic rubbers. Due to the inorganic properties pertaining to Si-O as the main chain in terms of the molecular structure, they are superior to ordinary organic rubbers in heat resistance, chemical stability, abrasion resistance and others. Because Si-O-Si key is the basic components of its key type, silicon atom main connection, the side chain was extremely small amount of unsaturated group, molecular interpolating force is small, the molecules in a spiral structure, methyl outwards and are free to arrange spin, so silicon rubber vulcanization after it has excellent resistance to high and low temperature [3, 4].

Therefore the vulcanization is a process, which crosslinks the molecular chains together, as seen in Fig. 1.

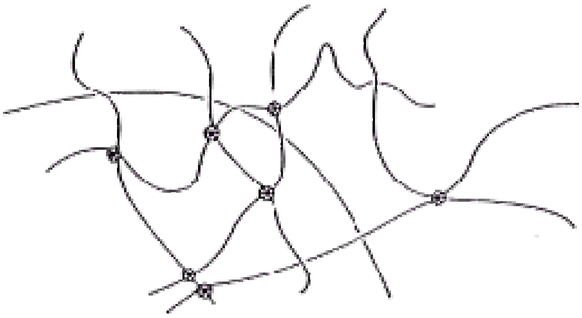

Fig. 1. Crosslink formation by vulcanization process

The most frequently applied method for evaluating of the vulcanizing parameters consists of taking measurements using several types of rheometers. These devices measure the time dependence of torque during the vulcanization of rubber blends [5]. The vulcanization curve can be described with a rheometer curve like in Fig. 2 and this process can be divided into three main phases

1. Induction of the process (scorch time),
2. Vulcanization,
3. Overvulcanization.

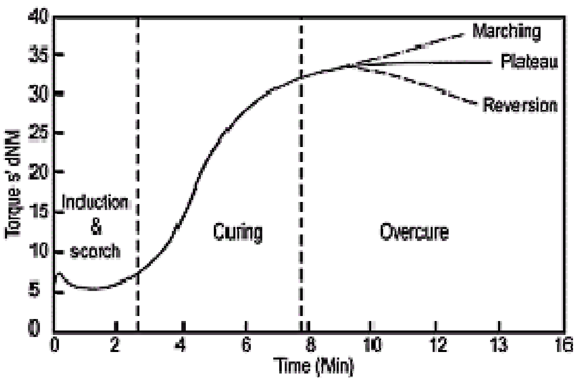

Fig. 2. Typical experimental behaviour of a rubber compound during rheometer test

The resistance to oscillation is measured and recorded as a function of the time on a rheometer chart like the one shown in Fig. 2.

Looking at the rheometer curve, three different cases can be encountered, see Fig. 2:

1, the curve reaches a maximum asymptotically,

2, the curve reaches a maximum and then decreases,

3, the curve increases monotonically after the scorching time t2.

3. EXPERIMENTAL PROCEDURE

The materials used were high temperature vulcanizable (HTV) silicone rubber with the commercial designation TEKSIL Silicone - HT-1M (White), TEKSIL Silicone - GP-S (Grey) and TEKSIL Silicone - LC (Brown). The vulcanization process was observed at temperatures from 140 to 180 ^{o}C with 10 ^{o}C increasing. It is worth noting that, in the oscillation disk, the curing temperature has to remain constant during all the vulcanization process. The vulcanisation pressure was 0,01 kPa and oscillation frequency 1,667 Hz. The rubber was cured in rheometer 60 min at given temperatures. The vulcanisation curves were recorded by Rheometer D - MDR 3000. The die cavity of Rheometer D - MDR 3000 can be seen on Fig. 3.

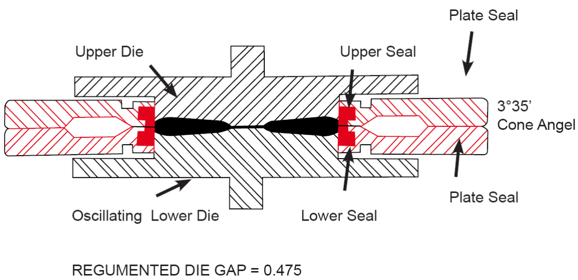

Fig. 3. D - MDR 3000 die cavity

Fig. 4 shows samples prepared from experimental materials after vulcanization in rheometer.

Fig. 4. Experimental samples

4. RESULTS AND DISCUSION

The rheometer curves at increasing controlled temperatures for for different experimental materials (TEKSIL Silicone - HT-1M, TEKSIL Silicone - GP-S and TEKSIL Silicone – LC) are show Fig. 5 – 7.

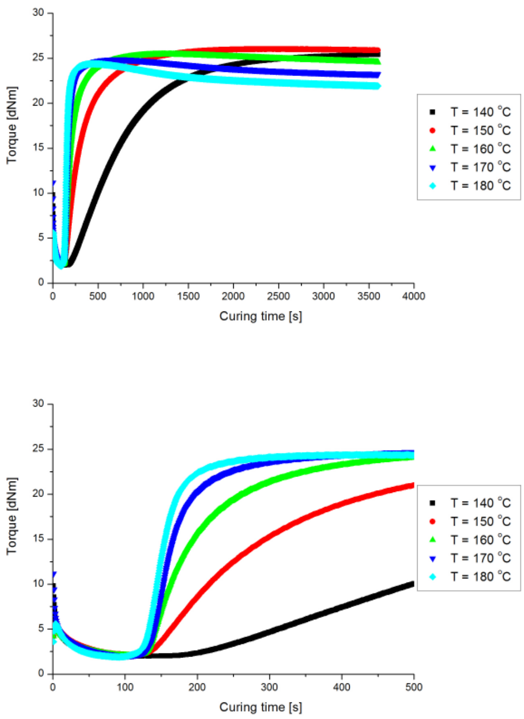

Fig. 5. Rheometer curves at increasing controlled temperatures (TEKSIL Silicone - HT-1M)

Fig. 5 shows rheometric curves of TEKSIL Silicone - HT-1M material at vulcanization temperatures from 140 to 180 °C. From curves is obvious that decreasing of vulcanization temperature causes increasing of optimal vulcanization time (t_{90}). The most significant change was observed at temperature 140 °C, opposite to vulcanization temperatures 170 °C and 180 °C where the change of optimal vulcanization time was minimal and vulcanization curves after achieving maximum (t_{100}) begin to decline even more than the vulcanization curve at temperature 160 °C. The vulcanization curves at temperatures 140 and 150 °C reach their maximums asymptotically.

Fig. 6 shows rheometer curves for TEKSIL Silicone - GP-S at vulcanization temperatures from 140 to 180 °C. All the curves but curve at temperature 160 °C have similar character as vulcanization curves for TEKSIL Silicone - HT-1M material with lower torque momentum values.

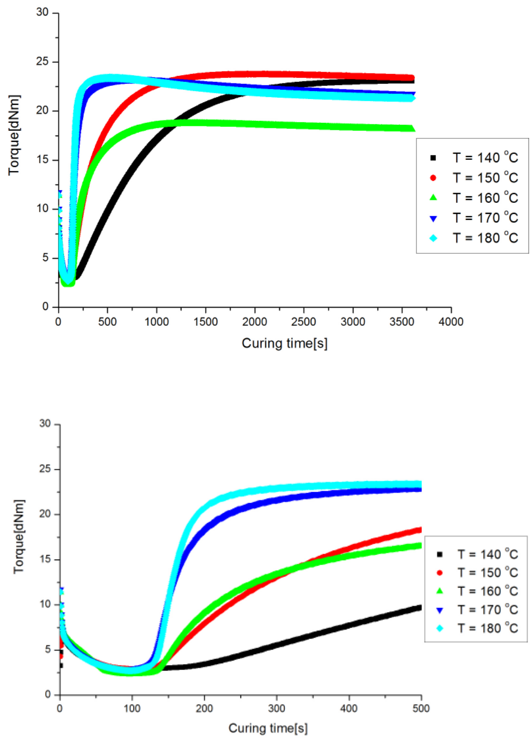

Fig. 6. Rheometer curves at increasing controlled temperatures (TEKSIL Silicone – G - S)

Fig. 7 shows rheometer curves for TEKSIL Silicone - LC at vulcanization temperatures from 140 to 180 °C. From these curves is obvious similarly to previous material, that decreasing of vulcanization temperature causes increasing of optimal vulcanization time (t_{90}). The most significant changes was observed at temperatures 140, 150 and 160 °C and only minimal change of optimal vulcanization time at temperatures 170 °C and 180 °C. At these latter temperatures similarly to previous materials the curves after achieving maximum (t_{100}) begin to decline, opposite to vulcanisation curves at temperatures lower than 160 °C, which after achieving scorching time t_2 shows monotonic qrowth.

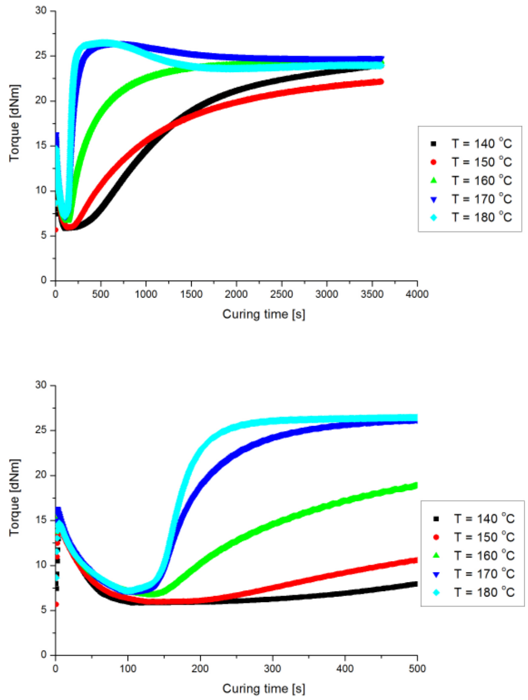

Fig. 7. Rheometer curves at increasing controlled temperatures (TEKSIL Silicone - LC)

5. CONCLUSIONS

It is obvious from experimental results, that material as so as influence the optimal vulcanization time. The results of these experiments can be used for determination of optimal vulcanization temperature and time of TEKSIL Silicone - HT-1M, TEKSIL Silicone - GP-S and TEKSIL Silicone – LC materials, used for production of silicone moulds for low melting point alloys spin casting.

From the results can be concluded that the most optimal vulcanization temperature for TEKSIL Silicone - GP-S and TEKSIL Silicone – LC is 170 ^{o}C, because the value of optimal vulcanization time decreases. This significantly affects mouldmaking process. Using this temperature causes only small decreasing of torque momentum, which influences the number of bonds created in silicone mould, thus incresing its thermal resistance and lifetime at casting process.

For TEKSIL Silicone - HT-1M material the optimal vulcanization temperature seems to be in range 160 – 170 ^{o}C. At temperature 160 ^{o}C there is no significant change of torque momentum after achieving its maximum value but the value of optimal vulcanization time slightly increases.

6. ACKNOWLEDGEMENTS

The financial support of grants from the Ministry of Education of the Slovak Republic VEGA 1/0383/10 is gratefully acknowledged.

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Resistance welding of steel sheets treated by nitrooxidation

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Abstract

Applying the nitrooxidation process to low carbon steels leads to significant improvement of mechanical properties and corrosion resistance. On the other hand, this type of treated steels is challenge for their joining. The reason is surface nitridic and oxidic layer with specific electrical and thermal properties. There were tested many arc and beam welding methods with less or greater success as well as the resistance welding. The present results in the field of resistance welding of steel sheets treated by nitrooxidation were poor, because the extremely long welding time was required. The paper deals with welding parameters optimization with regard to mechanical and microstructural properties of spot welds.

Keywords: Nitrooxidation; Resistance welding; Parameters optimization.

1. INTRODUCTION

Steel sheets with surface treatment are widely used in an automotive industry which works as motive power for their research, design and production. One of the non-conventional types of the thermochemical treatment is nitrooxidation in fluidized layer. It consists of surface nitridation with subsequent oxidation. The corrosion resistance as well as mechanical properties are significantly increased with this process [1,2,3].

In previous research activity, long welding times (50 and more periods) were tested with satisfactory results. Nevertheless, such a long welding times are considered to be inappropriate from the production point of view. This paper deals with the resistance welding of steel sheet treated by nitrooxidation with main focus on shortening the welding time and parameters optimization [4,5].

2. MATERIALS AND METHODS USED FOR RESEARCH

The material used for the experiments was thin steel sheet DC 01/DIN EN 10130-9 of 1 mm thickness. Chemical composition is presented in Table 1. The material was put through the process of nitrooxidation in fluidized bed, which was carried out in Kaliareň, plc. in Považská Bystrica. The nitridation fluid environment consisted of Al_2O_3 grains of 120 μm in diameter wafted by gaseous ammonia. After the nitridation process, oxidation process started subsequently. Oxidation itself was carried out in a vapours of distilled water. Parameters of nitrooxidation is shown in Table 2.

Table 1. Chemical composition of steel DC 01

C [%]	Mn [%]	P [%]	S [%]
max. 0.10	max. 0.45	max. 0.03	max. 0.03

Table 2. Parameters of nitrooxidation

Nitriding temperature [°C]	Nitriding time [min.]	Oxiding temperature [°C]	Oxiding time [min.]
540	45	380	5

Table 3 Welding parameters of specimens

Specimen No.	Welding time [per]	Welding current [kA]	Number of pulses	Welding force [kN]	Diameter of a lens [mm]	Welding voltage [V]	Note
1	15	4.4	2	1.4	4.8	0.98	good joint quality
2	8	4.7	4	1.4	4.2	0.86	good joint quality
3	5	4.7	6	1.4	4.6	0.84	good joint quality
4	22	3.7	2	1.4	4.2	0.88	good joint quality
5	11	3.9	4	1.4	4.5	0.77	good joint quality
6	7	3.9	6	1.4	4.2	0.77	incomplete fusion
7	17	5.7	1	1.4	5.6	1.03	good joint quality
8	8	5.3	2	1.4	4.6	1.16	good joint quality
9	6	6.0	3	1.4	5.0	0.92	good joint quality
10	15	6.0	1	1.4	5.6	1.07	good joint quality
11	12	6.7	1	1.4	5.6	1.10	spatter
12	9	7.6	1	1.4	4.9	1.10	spatter
13	15	6.1	1	2.2	5.3	0.99	good joint quality
14	12	6.8	1	2.2	5.4	1.06	good joint quality
15	9	7.7	1	2.2	5.2	1.09	spatter

Experimental activity was performed at Faculty of Mechanical Engineering at Slovak University of Technology in Bratislava. Total amount of 15 specimens were welded with different welding parameters. All specimens were welded on a ARO XMA (XM 3612A26E52) portable spot welding gun. The welding parameters of specimens are presented in Table 3. The diameter of the electrode contact surface was 4 mm and the split time in pulse welding was 5 periods.

The peel test as well as shear test were carried out in order to determine the joint quality. The macroscopic, microscopic analysis and the microhardness measurements were performed as well.

Regarding the previous outcomes, parameters optimization was done with main focus on shortening the welding time. There was a supposition, that the average value of resistance was the same during the welding process. As the source parameters, there have been chosen the joints with satisfactory results of the peel test but unsatisfactory results of the shear test. The product of the welding current square and the welding time, representing the value of 12 $kA^2.s$ was constituted as the initial value for parameters optimization. By an equation (1), several welding parameters could be suggested (see Table 3) regarding the constant value of 12 $kA^2.s$.

$$T = \frac{12}{I^2 x 0.02 x P_P}, \text{ where} \quad (1)$$

I – welding current [kA],

P_P – number of pulses,

T – time [per].

3. RESULTS AND ACHIEVEMENTS

Peel test results are given in Fig. 1 and Fig. 2. It can be stated that the fracture character was satisfied because the whole nugget together with the base material were pull out during the test. The results were similar to welded joints on a material without thermochemical treatment.

Fig. 1. Specimen No. 7 after the peel test

Fig. 2. Specimen No. 10 after the peel test

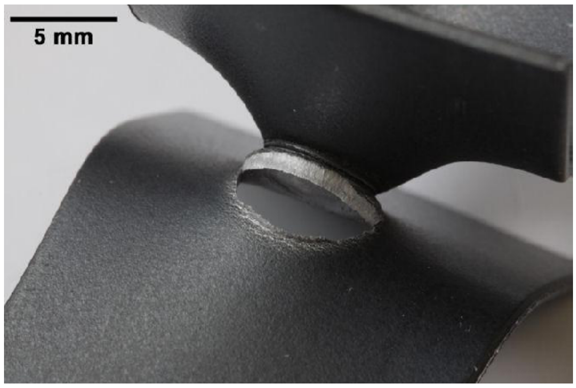

Fig. 4. Close-up look on specimen No. 7 after the shear test

Parameters of specimen No. 7 were chosen as a reference for the shear test. Total amount of four testing samples were made. The results of shear test are shown in Fig. 3. Close-up view on fracture area is shown in Fig. 4. During the test, pull out of the nugget together with the base material out of the heat affected zone was observed. By this fact, weld joints were marked as a suitable regarding the fracture character. The average force to failure value was 6.15 kN, which represented more than 19 % increase in comparison to specimens, in which the base material was not put through the process of nitrooxidation.

Fig. 3. Overall look on specimen No. 7 after the shear test

Results of macroscopic analysis are presented in Fig. 5. Picture shown, that the weld joint had a well shape, it was defects-free, such as cracks and porosity, which were the main issues in the fusion welding methods.

Fig..5. Macrostructure of joint (specimen No. 7)

Microscopic analysis showed that the weld metal, (see Fig. 6) had a bainitic microstructure. Along the columnar grains boundaries, a side ferrite was secreted. Small amount of martensitic structure was sporadically observed as well.

Fig. 6. Microstructure of weld metal (Specimen No. 7)

Results of the microhardness measurements confirmed the microscopic analysis, because of the microhardness values increase in weld metal caused due to presence of bainitic structure. Towards to the base material, microhardness values had decreasing trend.

4. CONCLUSION

In previous research activity, long welding times with satisfactory results were tested in welding of steel sheets treated by nitrooxidation by resistance welding. The objective of this paper was to evaluate the possibility to shorten the welding times as much as possible.

Results showed that even in shorter welding times, high quality joints were made. The peel test as well as shear test proved that the joints had superior mechanical properties, which, regarding the short welding times, were the main criteria in the choice of acceptance the joining method. Welding times were decreased in more than 66 % in comparison to previous outcomes.

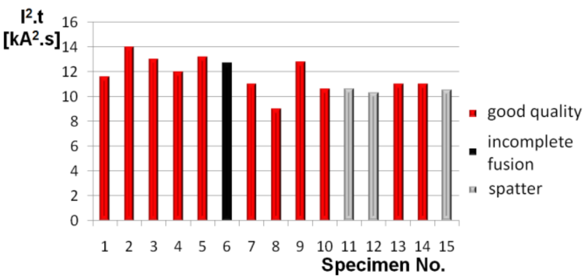

Fig. 6. Suitability of tested welding parameters

In Fig. 6, it is shown that the most of tested welding parameters were marked as a suitable. Therefore parameters optimization, with main regard to shortening the welding time, was successful. Only in three specimens, it was identified a small amount of spatter and one of the specimen had incomplete fusion defect.

5. ACKNOWLEDGEMENTS

This paper was prepared within the support of Slovak Research and Development Agency, grant No. 0057-07 and Scientific Grant Agency, grant No. 1/0203/11.

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The influence of spin casting parameters on dimensional accuracy of castings cast into silicon moulds

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Abstract

Paper deals with influence of mould rotation speed and clamping pressure during spin casting into silicon moulds on dimensional accuracy of zinc alloy castings. The rotation speed is in range 200 – 600 rpm. Clamping pressure was in range 40 – 55 PSi. The results of experiments are curves of rotation speed and clamping pressure on dimensional accuracy of castings.

Keywords: Silicon; Mould; Centrifugal casting; Rotation speed.

1. INTRODUCTION

The centrifugal casting technologies utilize the centrifugal force to fill the mould cavities by molten material. The centrifugal force is generated by mould rotation [1]. The spin casting technology into silicon rubber moulds also belongs to these technologies. The rotation speed of cast mould is one of parameters which influence final quality of castings [2, 3]. Shape of runners and the method of mould cavity feeding by molten material are the next factors that influence the production result of casting process. The method of mould cavity feeding along with rotation speed influence the molten material filling into the mould cavity, if it fills it fluently, or the mould cavity will be filled by turbulence filling with drastic liquid collision. [4].

2. METHODS AND MATERIALS USED FOR RESEARCH

The aim of experimental was to determine the influence of clamping pressure and mould rotation speed on dimensional accuracy of zinc castings, cast by spin casting into the silicon rubber moulds. Four types of aluminium circular-shaped patterns were manufactured by CNC milling machine (Fig. 1). The patterns diameters were 60, 50, 40 and 30 mm. The thickness of patterns was 5 mm for each diameter. By means of the patterns, the experimental mould was manufactured.

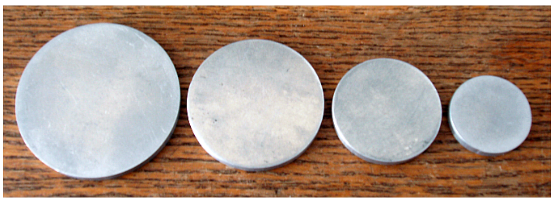

Fig. 1. Aluminium patterns

The distance, between the middle of each pattern and the mould rotation axis was 110 mm. Silicon rubber White SD THT with diameter 12” was used as a moulding material. The experimental mould is shown in Fig. 2.

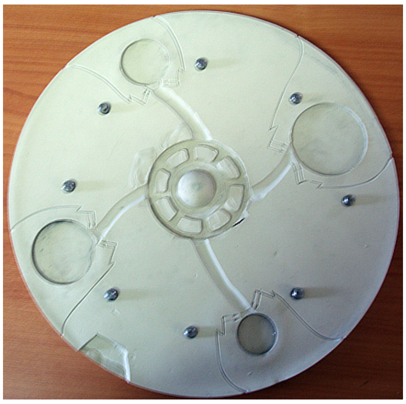

Fig. 2 Experimental mould

Experimental mould was vulcanized in Digital hydraulic 3-post vulcanizer – 50 TON/EA and the vulcanization time was 2 hours. Pressure of vulcanization process was 3500 PSi and vulcanization temperature 170 °C.

Experimental castings were cast by Tekcaster Series 100D casting machine. Cast material was zinc alloy ZnAl4Cu3. The chemical composition of cast alloy is in Table 1. Casting temperature of zinc alloy was 425 °C.

Table 1. Chemical composition of zinc alloy ZnAl4Cu3

ZnAl4Cu3 (EN 12844)	Al	Cu	Mg	Pb	Cd
	3,7 - 4,3	2,7 - 3,3	0,025 - 0,6	max. 0,005	max. 0,005
	Sn	Fe	Ni	Si	Zn
	max. 0,002	max. 0,05	max. 0,02	max. 0,03	rest

Clamping pressure during casting was established to 40 PSi; 45 PSi; 50 PSi a 55 PSi. Mould rotation speed was established for each value of clamping pressure, in range from 300 rpm do 600 rpm, with step 100 rpm. Time of casting process was 35 seconds.

Experimental castings were measured by micrometers Schut 0 – 25 mm, 25 – 50 mm a 50 – 75 mm, with accuracy 0,01 mm. Castings diameters, across the direction and in direction of molten metal flowing, were measured (Fig. 3).

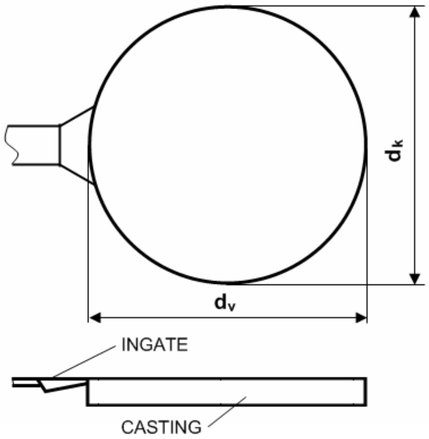

Fig. 3. Measurement locations of experimental casting

3. RESULTS AND ACHIEVEMENTS

Average values of diameters were calculated for each combination of analyzed parameters. Graphs from calculated values are shown in Fig. 4 - 7. In figures are shown particular dependencies of both diameters on clamping pressure and mould rotation speed, for each experimental casting diameter. The percentage value presents the deviation of casting from pattern.

Fig. 4 shows the dependency of d_k and d_v diameters on clamping pressure and mould rotation speed, for experimental casting with 30 mm diameter. From graph is obvious that increasing of mould rotation speed caused the increasing of d_k diameter up to 2,5 %. The d_v diameter increased about 1,5 %. Change of clamping pressure influenced the deviation of d_k and d_v diameters significantly only over 45 PSi.

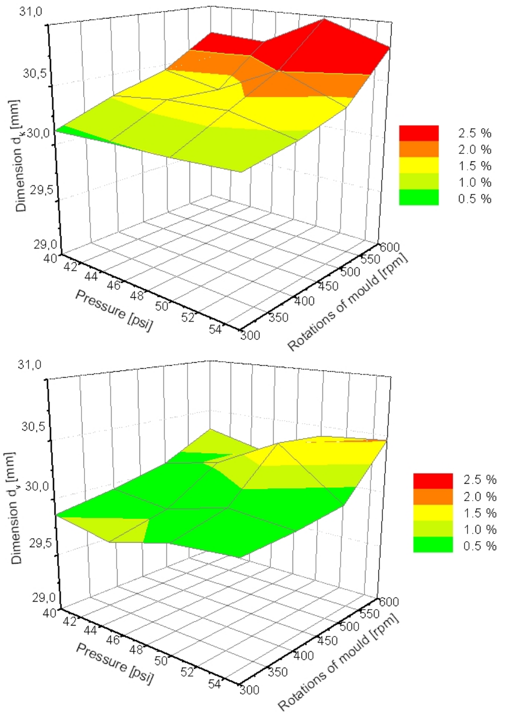

Fig. 4. Dependency of diameters accuracy for 30 mm casting diameter

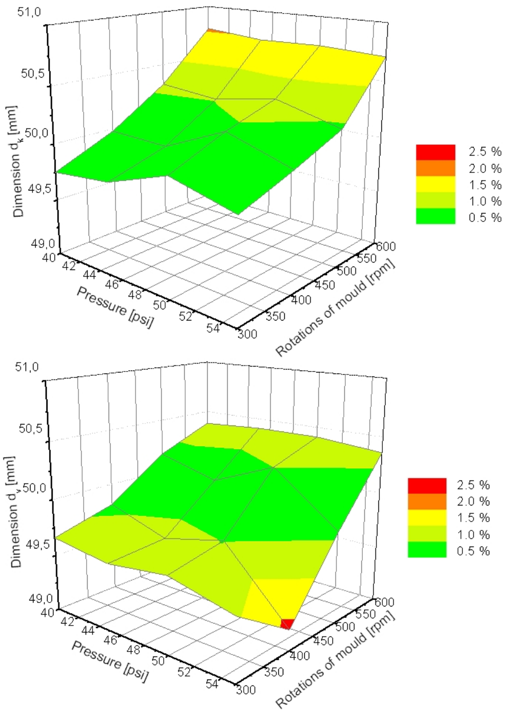

Fig. 6. Dependency of diameters accuracy for 50 mm casting diameter

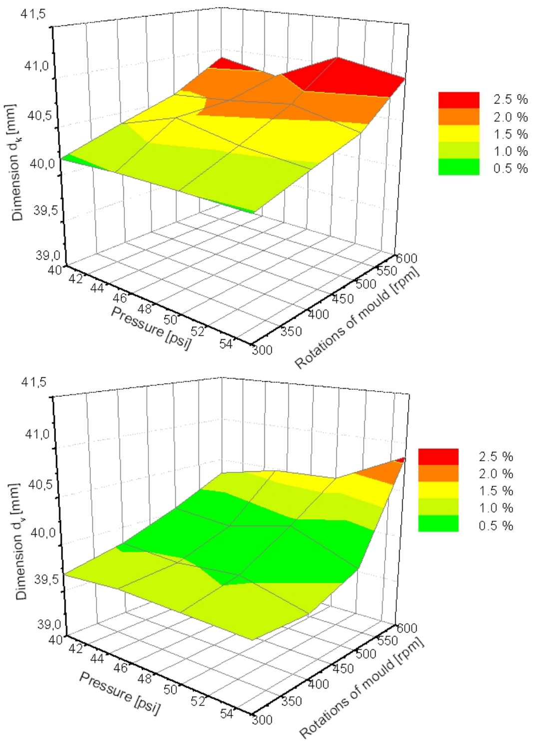

Fig. 5. Dependency of diameters accuracy for 40 mm casting diameter

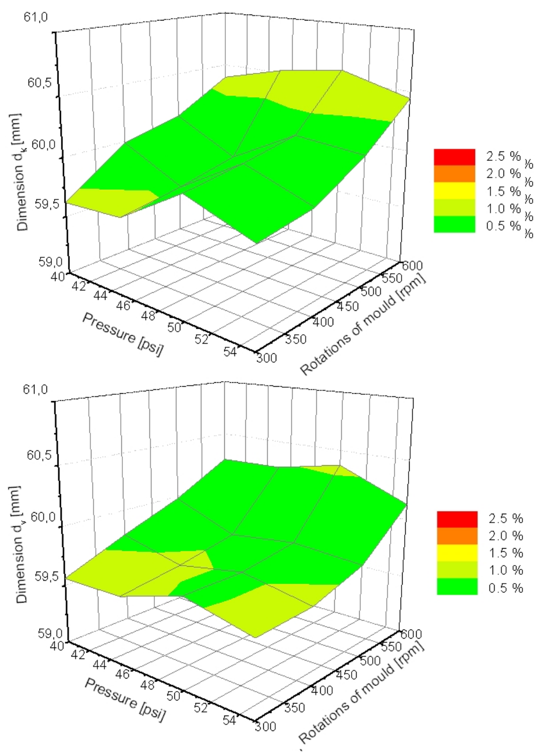

Fig. 7. Dependency of diameters accuracy for 60 mm casting diameter

Fig. 5 shows the dependency of d_k and d_v diameters on clamping pressure and mould rotation speed, for experimental casting with 40 mm diameter. In graph is obvious that increasing of mould rotation speed caused the increasing of d_k diameter deviation up to 2,5 %. The d_v diameter increased about 2,5 % only at rotation speed 600 rpm and clamping pressure over 50 PSi. Change of clamping pressure influenced significantly the d_k and d_v diameters accuracy only at rotation speeds over 500 rpm and about 50 PSi and 55 PSi.

In Fig. 6 is shown the dependency of d_k and d_v diameters on clamping pressure and mould rotation speed, for experimental casting with 50 mm diameter. It was possible to observe that increasing of mould rotation speed caused increasing of d_k diameter deviation up to 1,5 %. Diameter d_v increased about 1 %. Change of clamping pressure had no significant effect to casting accuracy. However, negative effect of high clamping pressure was observed only at 300 rpm and over 50 PSi.

The dependency of diameters d_k and d_v on clamping pressure and mould rotation speed, for experimental casting with 60 mm diameter is shown in Fig. 7. In this case, the diameters increased only to 1 % for each combination of analyzed values of parameters. At rotation speeds in range from 300 rpm to 500 rpm, the deviation of d_k diameter was to 0,5 %. The clamping pressure changed significantly the deviation only over 50 PSi, even tough the increasing of diameters was only to 0,5 %.

The small difference of accuracy of d_k and d_v diameters caused the effect of centrifugal force [4].

4. CONCLUSIONS

From obtained experimental results was determined that rotation speed and clamping pressure influence the casting accuracy. Rotation speed has the major influence. Rotation speed increasing causes increasing of casting deviation, at castings with diameter 30 mm and 40 mm. At increasing of casting diameter is optimal to increase the rotation speed, in order to decreasing the deviation.

Increasing of clamping pressure significantly influences the accuracy only at higher rotation speeds.

For 30 mm and 40 mm casting are most optimal the mould rotation speeds to 400 rpm. The effect of change of clamping pressure is non significant by rotation speeds to 400 rpm. For 50 mm casting are most optimal the mould rotation speeds in range from 400 rpm to 500 rpm. Change of clamping pressure changes the accuracy no significantly, only over 50 PSi. For 60 mm casting is most optimal the range of rotation speeds in range from 350 rpm to 550 rpm. Clamping pressure is not very optimal over 50 PSi.

5. ACKNOWLEDGEMENTS

The financial support of grants from the Ministry of Education of the Slovak Republic VEGA 1/0383/10 is gratefully acknowledged.

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Technology of making pump body

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Abstract:

The theme of this paper is projecting tehnology of pump construction. Tehnology of pump construction were projected and tehnologic requirements and used material were analizied. The paper focuses on the technology of milling the thread. We made a selection of cutting tools, devices, measure equipment and tool machines and necessary means for cooling and greasing. At the end is made the economic analysis of construction technology, and referred the proposal to improve.

Keywords: Pump body; Milling thread; Drilling.

1. INTRODUCTION

This paper is the design of technology development of the pump body. Solution to the problem included: specificity and requirements that are placed in the design of production technology, production technology development, selection of necessary tools and equipment, the requirements in the selection of used machine tools, technological capabilities, and techno-economic analysis of the presented technologies.

Influential factors in the choice of making some of his size, shape, material and production resources available in the form of tools, available time, and well made the process of technological preparation of production. The choice of tools affects the production time, and thus the overall cost of production. This choice also depends on the characteristics of machine tools, also affects the quality of processing is necessary to meet all the requirements that are placed into production.

At the present time is set a few requirements before the Company engaged in machining, and some of them are:

-Satisfactory quality of treatment
-Compliance with delivery deadlines
-Low production costs
-The rational management of resources

Pumps are machines through which fluid or liquid transported or sourced from a lower level to a higher level or area of low pressure in the area of higher pressure, a difference in the levels and pressures, overcoming adding energy system.

Pumps are machines in which mechanical energy is brought from outside, as the machine's work transforms the energy of the working fluid.

2. MATERIAL FOR MAKING BODY PUMP

Material of the pump body is made Č5431. It is a low alloy steel for improvement. These steels are used after hardening and high-relaxation (improvement). These steels contain 0.3 to 0.5% C and subjected to a tempering temperature from 820-880 ° C (depending on the composition) in oil (large pieces hardening in the water) and temperature for high relaxation at 500-650 °C. These steels have high yield limit (Rp 02 = 1300 N/mm2) and good strength and toughness. It is beneficial to limit fatigue or slowly these steels bother, and besides that are resistant to dynamic stress, alternating stress and shock [1].

Table 1. Chemical composition of steel Č5431[1]

Steel	C %	Si %	Mn %	Cr %	Mo %	Ni %	V %	P % max	S % max
Č5431	0,30–0,38	0,15–0,40	0,40–0,70	1,40–1,70	0,15–0,30	1,40–1,70	——	0,035	0,035

Chemical composition of steel Č5431 by the housing body of the pump is shown in Table 1, temperature hardening and relaxation in Table 2.

Table 2. Temperature for hardening and relaxation for steel Č5431[1]

Steel	Temperature of hardening		Temperature of relaxation °C
	in water °C	in oil °C	
Č5431	820–850	830–860	540–680

3. TECHNOLOGICAL AND ECONOMIC LIMITATIONS

Since it is a small series, the cost of purchasing tools is divided on three workpieces, which means that the tool costs are very high per item.

Favourable fact is that these threads have the same pitch, which means that it is possible to find a tool which could thread mill both M56x4 and M110x4. Tapping is possible for M56x4, but that would mean buying two tools: thread mill for M110x4 and thread tap for M56x4. However, the fact that both treads don't have relief groove at the bottom was crucial for decision that the threads should be made by milling, and not by tapping. In addition it is assumed that the use of milling tools for future activities will result in lowering of initial tools costs per item.

When the thread is particularly deep, a tap may shine. A long tap can machine threads effectively in a hole that goes a long way down. This is not the case with a thread mill. In thread milling, because the cutting forces are not balanced, the tool is prone to deflect. Beyond a certain depth, the deflection becomes too great to machine the thread well. In general, a thread mill is limited to a depth of about 2,5 times the diameter of the tool for metric and 1,5 times for metric fine threads. [2]

3.1. Technological limitations

- Large difference in diameter and depth of threaded holes - the possibility of vibration when using a one tool for depth of 65 mm and depth of 120 mm
- The tool must have sufficient stiffness - it is assumed cylindrical holder of sufficient length that can be adapted to the depth of the thread hole. In deep threading it is important to use a tool with a greater diameter and shorter overhang to reduce vibration of the tool. The use of longer, less rigid tool reduces the stability and has a bad impact on the overall performance of the tool. In the case of tools with cylindrical shank the length can be shortened by cutting the tool body.
- Processing quality - it is necessary to reduce the load on the cutting edge. It is supposed to use a insert with a one cutting profile on the top
- Processing quality - removal of the chips from the bore by cooling through the spindle assure a longer tool life, better removal of chips and a better surface quality of threads.
- Processing quality – machining of quenched and tempered materials requires reduction of load on the cutting edge. It is necessary to use inserts with one cutting profile on the top.
- Processing quality - using tangential helical arc at the entry and at the exit of thread

gradually increases/decreases load on the cutting edge which reduces the potential for vibration and extends tool life.

- Choice of the machine – thread milling requires CNC machining center with cooling through the spindle and the possibility of helical interpolation.
- Processing time - it is necessary to work with high feed rate because helical path is long. Feed rate is the function of rotational velocity, feed per tooth per rotation and number of cutting edges (flutes). The use of a tool with more flutes is assumed.

4. TOOL SELECTION

Based on the request to use a one thread milling tool for thread M56x4 with the depth of 65 mm and M110x4 with the depth of 120 mm, a tool with a cylindrical shank and cooling through the spindle was selected.

Based on the request to reduce the load on the cutting edge, tool with inserts having one cutting profile on the top was selected.

Based on the request to reduce processing time by increasing the feed rate, tool with a minimum of 3 flutes was selected.

The characteristics of the chosen tool are:
Manufacturer: VARDEX

Mill: TM3SC-28C35-144-3A

($L1_{max}$=144 mm, L2=4 mm)

Insert: 3AIDT60 TM (L=16 mm, r=0,08 mm),

Carbide – VTX (for general purpose and steel)
The range of pitch: 2,0-4,0 mm; 12-6 tpi
Number of flutes: 3

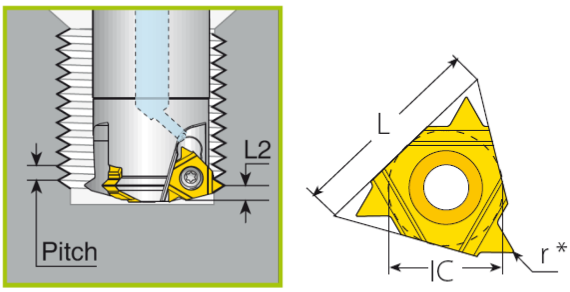

Fig. 1. Tool for making thread

5. THREAD MILLING OPERATION

The thread milling operation consists of circular rotation of the tool around its own axis together with an orbiting motion along the bore or workpiece circumference. During one such orbit, the tool will shift vertically one pitch length. These movements combined with the insert geometry create the required thread form.

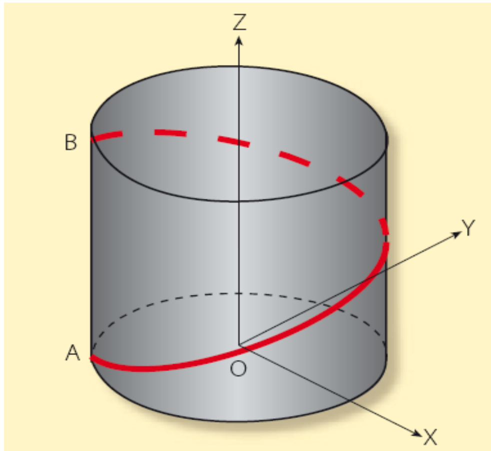

Figure 2. Helical toolpath [3]

5.1. Milling method

Conventional milling method is chosen. Milling from the top to the bottom of the thread is used for hard materials. The equations define the relationship between feed rates at the cutting edge and at the tool center line.

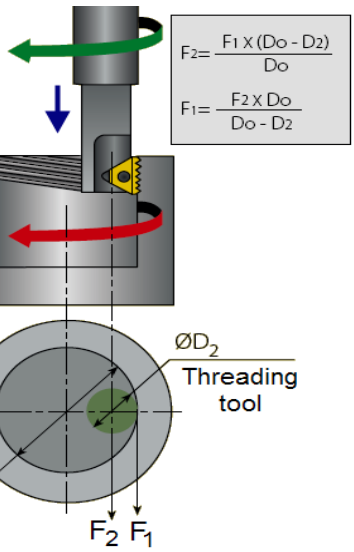

Figure 3. Milling method[4]

There are two acceptable ways of approaching the workpiece with the tool to initiate production of the thread:

- Tangential Arc Approach
- Radial Approach.

6. SELECTION OF CUTTING REGIME

Cutting speed: 100 m/min
Feed per tooth: 0,26 mm/rev
Path type: continuous
Passes radial: 2
First pass of profile height: 85%
Second pass of profile height: 15%
Cutting time: 29 min 54 sec

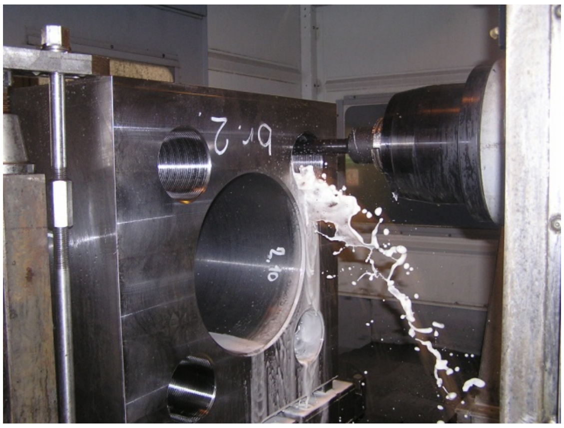

Fig. 4. Thread milling operation on CNC machining center

Fig. .5. Thread M110x4 with the depth of 120 mm

7. CONCLUSION

Thread milling example that was used to represent the factors of choice of tools for large internal threads was done in production with very good results. Quality of machining on the thread M56x4 was satisfactory. During the thread milling of M110x4 with the depth of 120 mm, vibrations appeared but the quality of thread was not compromised except the visual trace of tool vibration. Purchasing of only one tool for thread cutting, consciously depart from the rules set by the manufacturer that the mill diameter must be 70% of the tread's diameter. Since inserts cover the range of pitch from 2-4 mm, generated program for pitch 4 mm with two passes was not sufficient to finish threading.

During the thread milling of the first thread there was an excessive vibration when mill started tangential entry into the material. It turned out necessary to mill a thread in 4 passages which increased the time of operation. For a series of 3 pieces it was not a big problem. However, in the case of larger series, it would be necessary to obtain and thread mill for M110x4 with the depth of 120 mm and generate machine code in three passes that would be enough for good thread quality.

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Formation of surface layers with laser cladding technology with additional material in the form of wire

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Abstract

The paper presents the creation of the surface layers with laser cladding technology using additional materials in the form of wire with a direct addition to the process of cladding. Creating layers with laser use laser heat source, which allows a thin layer of deposited metal required on the processing of material (substrate). Created layers will be evaluated with metallographic methods and testing on abrasive wear resistance.

Keywords: Laser; Laser layers; Cladding; Laser technology; Wire; Abrasive wear resistance.

1. INTRODUCTION

Creating functional layers with cladding technology by using traditional methods, such as arc cladding and plasma spraying requires high heat input, which often leads to an increase in the heat affected zone. In contrast, thermal processes applied in the laser cladding, which take place in the action of laser radiation on the surface layer of material, having a high rate of heating and cooling, unattainable with traditional cladding methods. Besides such peculiarities of thermal processes are laser cladding offers several other advantages such as low values mixing of base material with cladding material, the minimum value of deformation of shape influence heat inserted into the process, little or no subsequent machining of many others.

Laser surfacing is relatively young, unconventional technologies, with many potential uses. Quite often it is used to repair and rebuild worn or damaged surface parts when renovation brings us not only to recover the original surface properties, but using the appropriate additional material for cladding, and their improvement [1].

1.1. Cladding technology

The source of the laser beam for laser cladding may be different types of lasers, for example solid state lasers or CO_2 lasers. Method of application for additional cladding material can be divided into:

- Technology that uses applied additional material in the form of metal paste or in the form of spraying metal powder.
- Technology which is additional material transported to the site during the process of cladding and in the form of metal powder or wire.

The laser cladding using the additional material in the form of a wire is one of the main demands accurate adjustments can supply wire to the reference point, respectively to the weld point where is interaction with the laser beam. To achieve this requirement is necessary that the feed device for cladding to achieved and maintained throughout the process high accuracy of additional wire [2].

2. EXPERIMENT

The research of layers created with laser cladding is used these materials and equipment:

- Laser device of type Feranti Photonics AF8 with power 8 kW, with a wavelength of 10,6 µm. For laser cladding process used technical parameters specifications in the table 1.
- As the base material was designed and used structural steel S355J2G3 (11 483).
- As additional material in the form of wire were designed and used cored wires PZ6159 PZ6168 with a diameter Ø 1,6 mm, chemical composition of the wires are shown in tables 2., 3.

Table 1. Technical parameters of laser cladding [3].

Base material		S355J2G3	
Additional materials		PZ6159	PZ6168
Power of laser beam	[kW]	4,7	
Cladding speed	[mm/s]	5	
Wire additional speed	[mm/s]	25	
The flow of shielding gas	[l/min]	16	
Head distance from the material	[mm]	40	
The angle of inclination of the wire nozzle	[°]	35	

Cored wire PZ6159 can be characterized as a cored wire for cladding, in cladding metal includes tungsten carbide in the martensite matrix and it can withstand temperatures up to 500 ° C. Processing the cladding layers is possible only by grinding. This wire is suitable for cladding parts working at elevated temperatures, for example, parts of the annealing furnace, but also for cladding the cutting tools working in heat. Hardness of cladding metal is 49-55 HRC. Chemical composition of pure cladding metal is shown in table 2. [4].

Cored wire PZ6168 can be characterized as cored wire, used for cladding of parts working under conditions of abrasion combined with surges at higher temperatures. Typical applications of this additional material are in the brick industry but at the cladding of parts from hopper elements of the blast furnace. Processing the cladding layers is possible only by grinding. Hardness of cladding metal is 56-61 HRC. Chemical composition of pure cladding metal is shown in table 3. [4].

Table 2. Chemical composition of pure additional material (%) [4].

Označenie	C	Si	Mn	Cr	Co	Mo	V	W
PZ6159	0,4	1,1	1,1	1,8	2,0	0,4	0,4	8,0

Table 3. Chemical composition of pure additional material (%) [4].

Označenie	C	Si	Mn	Cr	Mo	Nb	V	W
PZ6168	4,5	0,7	0,7	17,5	0,9	5,0	1,0	1,0

3. RESULTS AND ACHIEVEMENTS

To evaluate the quality of layers were chosen following methods:

- Metallographic observation of integrity and layer structure in transverse sections of made samples.
- Measurements of microhardness. Microhardness was measured at very small distances between the injection sites. It is denouncing of structure characters and its homogeneity. The interface of layer with substrate is indicative of joint characters and size of mixing addition material with the substrate.
- Tests for abrasive wear resistance. The test is standardized according to STN 01 5084. The principle of the abrasive wear test is in wear of samples with abrasive cloth [5].

3.1. Macrostructure

Macrostructure of laser cladding samples is shown in Figure 1a, 1b. Clad of these samples appeared to be relatively homogeneous.

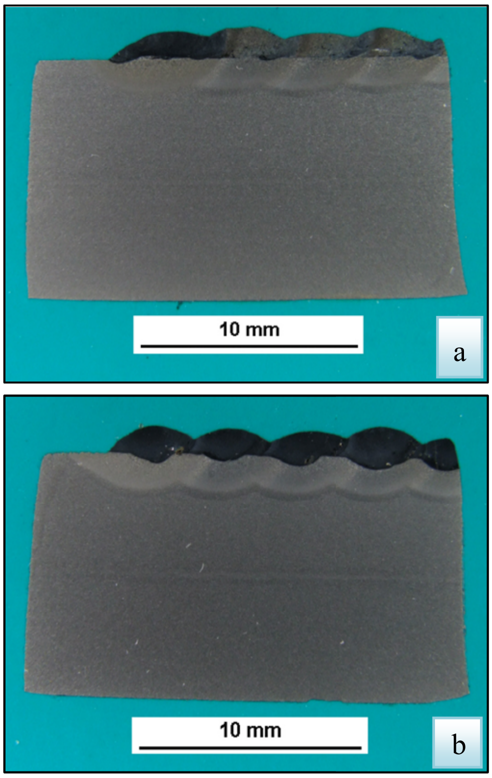

Fig. 1. a) macrostructure of sample PZ 6159, b) macrostructure of sample PZ 6168

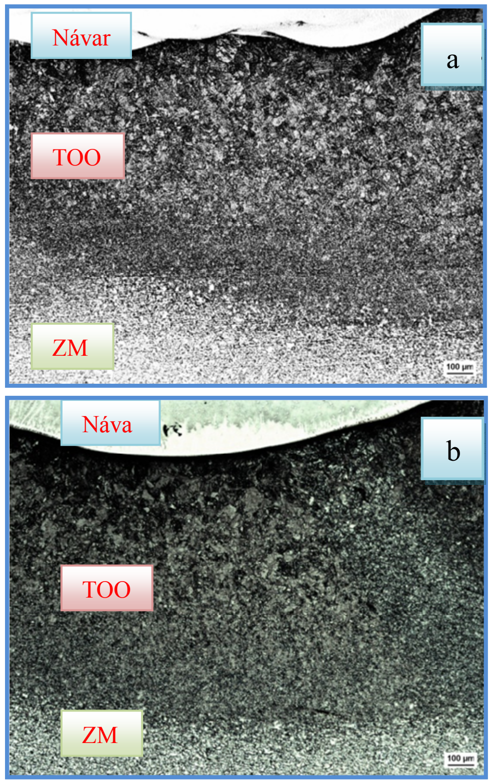

Fig. 2.Microstructure of sample made by the wire a) PZ6159 on base material S355 J2G3, b) PZ6168 on base material S355 J2G3

3.2. Microstructure

Observation of microstructure clads deposits held by light optical microscopy, by device NEOPHOT 32, in conjunction with an image analyzer Lucia G. Microstructure of the clad samples with additional material PZ 6159 was formed acicular ferrite where the frontiers columnar grains can be excluded polyhedrosis ferrite figure 2a.

Dendrite microstructure has the clad with additional material PZ 6168, while the dendrites are composed of solid solution (in particular Fe and Cr). In the between-dendrites area is excluded eutectics, which due to the chemical composition of the additional material may be formed by a mixture of solid solution α and carbides alloying elements in figure 2b.

3.3. Microhardness

Microhardness was measured in transverse sections of samples at distances of 0,2 mm in clad and 0,1 mm in the heat affected zone and in base materials. The starting point was just below the surface of the clad was measured and gradually was measured to the base materials. Load power were 100P (0,98 N) and loading time was 10s. This test was performed according to Vickers on microhardness device HANEMANN. Samples with additional material PZ6168 had higher average microhardness (fig. 3) [3].

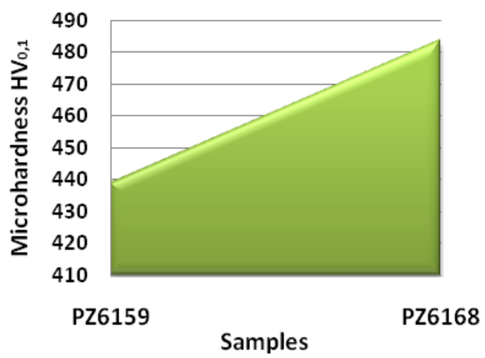

Fig. 3. The average microhardness values of samples

3.4. Abrasive wear

For assessment of abrasive wear resistance was used laboratory equipment to test wear on abrasive cloth in accordance with STN 015084. In table 4. is used test conditions.

Table 4. Test conditions [6]

Test sample of average	10 mm
Contact pressure	0,32 MPa
Transverse displacement	3 mm.ot^{-1}
The wear rate	0,15 ÷ 0,48 ms^{-1}
Friction track	50 m
Abrasive cloth is corundum with granularity	100

As a standard for evaluating the relative abrasive wear resistance ψ_{abr} was used steel 12 014.2. Relative abrasive wear resistance ψ_{abr} was evaluated according to STN 015084 [6].

The measured and calculated values of relative abrasive wear resistance shows that the highest proportion of abrasive wear resistance Ψ_{abr} = 3,6754 achieved sample which was used as additional metal cored wire PZ 6168, has been cladding with laser technology to the base material S355J2G3 (11483).

4. CONCLUSION

After evaluating the results obtained, analysis and all tests was concluded that even with the same parameters used cladding was demonstrated different wear resistance of clad when the best result achieved sample no. 1, in which was used PZ6168 cored wire to the base material S355J2G3 using laser cladding technology by the performance of 4,7 kW laser beam with achieving an average microhardness 483,6 $HV_{0,1}$.

It is evident that the cladding can be used in the manufacture of new tools and components as well as the renovation of component wear, given the fact that the cladding can increase the life of tools and components for high efficiency, saving the base material, raw materials and energy [3].

5. ACKNOWLEDGEMENTS

This paper was supported by projects VMSP-P-0009-09 and VMSP-P-0008-07.

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Growth of the IMC at the interface of SnAgCuBi (Bi=0,5;1,0) solder joints with substrate

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Abstract

The aim of article is study the influence of Bi on the microstructure evolution of lead-free solder joints in microelectronics. The key factor affecting the reliability of electronic products are the interfacial reactions in solder joints which the secondary products are brittle intermetallic compounds. Creation and growth of intermetallic compounds is dependent on the chemical composition of solder and base material, on the effects time of melt solder on the base material and on the operating temperature. It is very important to let know that these reactions is not creation only near contact of base material with melt solder in melting time and cooling time a solder joint, but it is followed to solidification of solder too.

Keywords: Soldering; Lead-free solder; Reliability; Intermetallic compound.

1. INTRODUCTION

The unhealthy effect of lead to the environment and human health accelerate the research and development of solder in direction of the completely elimination of lead. The lead-free solders besides the higher melting temperature, worse wettability (from this different temperature profile, different flux...) are different from the lead containing solders also with different electrical and mechanical properties.

Most of lead-free solder alloys are setup mainly to the addition of small amount of third and fourth alloy to the binary alloy to increase their condition. Bismuth is added to the solder alloys in order to decreasing the melting point, advance mechanical conditions and increasing of creep resistance. Bismuth also advance the wettability, what can to play the role in the using of lower soldering temperature [1, 4].

The alloy systems with the Bi addition are used by the Japanese producers of electronics. It is used the alloys with the high amount of Sn, mainly SnAgBi, SnAgCuBi.

The typical compositions are tested by Japanese project NEDO (New Energy and Industrial Technology Development Organization) – SnBi3.0Ag2.0Cu0.5 and after it by project IMS (Intelligent Manufacturing Systems) – SnAg3.0Bi2.0Cu0.5. To the reduction of melting temperature and better wettability are preferred only low amount of bismuth containing. The addition of higher amount approximately 5-20% Bi decreasing the melting point to the temperature of eutectic SnPb solders, but they lose the good conditions of SnAgCu alloy system [6].

The most widespread questions in lead-free solder reliability is the intermetallic compounds growth, which are localized to the interface between solder and substrate. All known basic materials and coatings in electronic products create with the melted solder with active element (Sn) the intermetallic compounds (IMC) at the interface solder – substrate. Their existences at the contact area indicate, that was created the good metallurgical joint [2].

Unwilling is mainly the excessive IMC growth, indicated by joint heating in working process (changes of atmosphere temperature or temperature changes by heat abstraction from the cover), in case of IMC growth to the heavy thickness and the interface solder – IMC take place of the source of crack creation and extension.

The growth begins at the room temperature and continues to the area of working temperature of electronics. All growth of layers and cracks brings together the degradation of mechanical and electrical properties, which become the decrease of electrical conductivity of joint. Than more cracks in the layer, than higher transfer resistance, which cause the higher heat strain of joint and layer and cracks further expanded. This process leads to the joint degradation and gradually to the non-functional joint [3, 7].

The excessive growth also consumes the basic metal and thereby become to the gradual reduction of soldered joint. This may flow into the adhesion loss to the substrate, which is not wetted by solder, or may be the crack creation due to the strain in intermetallic compound, because of too thickness [3, 5].

2. METHODS AND MATERIALS USED FOR RESEARCH

For experiment was chosen the fours element alloys SnAgCuBi with the small amount (0.5 and 1.0%) of Bismuth. As the basic material was used the often material used in electronics the Cu with 99,995 % purity. The joints Cu – SnAg1.0Cu0.5Bi0.5 and Cu – SnAg1.0Cu0.5Bi1.0 was created by hot plate soldering. The soldering temperature was 255°C through 5 s.

The samples produced was subsequently annealing at 160 ° C for 15 days and shall be collected from the vacuum furnace at intervals of 1, 3, 7, 11 and 15 days.

For observations of IMC (shape and size) present in the structure of solders and at the interface of soldering joints is used light optical microscopy. To assess the representation of different phases present was carried the line EDX microanalysis.

3. RESULTS AND ACHIEVEMENTS

The microstructure of the interface of soldering joint Cu - SnAg1.0Cu0.5Bi0.5 after soldering process and then soldering heat affected is shown in Fig. 1a, b.

After soldering (Fig. 1a) is the structure of solders SnAgCuBi0.5 consisting predominantly with fine-grained structure. In the volume of solder are dispersed the phases Cu_6Sn_5 and Ag_3Sn which after the heat affecting change their shape and size. These phases are formed from Ag and Cu, which are contained in the composition of solders.

Given that the use of soldering materials based on Cu and Sn can be observed at the interface of Cu-substrate/solder creation of IMC Cu_6Su_5. Size layer of IMC does not get over 1μm. After annealed is created further reaction layer at the interface of substrate the phase Cu_6Su_5 documented as Cu_3Sn (Fig. 1b).

Growth of Cu_3Sn phase can be explained by the fact that the great thickness of Cu_6Sn_5 phase leads to diffusion of Cu at the interface and due to the lack of Sn at the interface of solder joint creation the phase rich in Cu (Cu_3Sn).

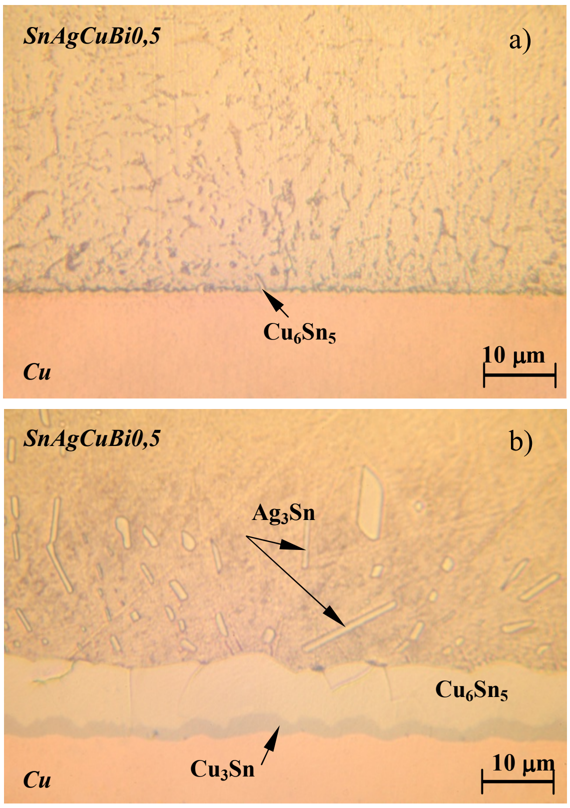

Fig. 1. Microstructure of the interfacial area of Cu-SnAg1.0Cu0.5Bi0.5 solder joint a) after soldering T = 255°C, t = 5 s, b) aged at 160°C for 360 h

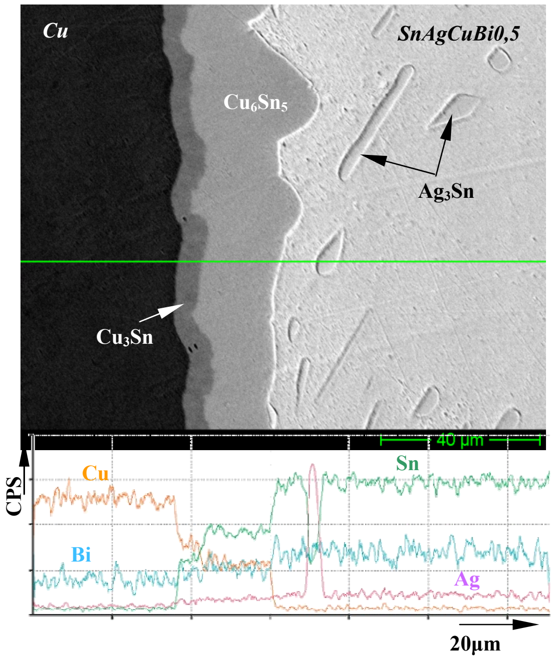

Fig. 2. Linear EDX microanalysis of Cu – SnAg1.0Cu0.5Bi0.5 solder joint interface aged at 160°C for 360 h

Morphology of the IMC is significantly different from each other. IMC Cu_6Sn_5 is initially characterized by its high inequalities in comparison with laminated Cu_3Sn phase. Over time, however serrated shape of Cu_6Sn_5 phase takes laminated shape with a unique layered scallop. For the time of 360 h of annealing was a relatively continuous layer of the two phases with an average thickness of 22 µm.

In Fig. 2 of the line EDX microanalysis observes the structure of heat affected soldering joint together with the individual increased phases. The line analysis confirms the presence of phases Ag_3Sn and Cu_6Sn_5 near the interface. Generally, however, larger particles tend to Cu_6Sn_5 phase and smaller particles to Ag_3Sn phase.

Structure of solder SnAg1.0Cu0.5Bi1.0 after the soldering shows granular structure (Fig. 3 a). Apart from scattered Ag_3Sn phase of various shapes and dimensions was observed in the volume of solder the creation of Cu_6Sn_5 in the form of the letter "F". During the annealing of solder joints there is a change to the growth and change in shape of IMC.

The sequence of creation at the IMC is the same as in SnAnCuBi0.5 solder, ie, as the first is creation Cu_6Sn_5 phase and up to the heat affected is creation the second phase Cu_3Sn (Fig. 3b).

Compared with solder containing of less Bi the thickness of IMC decreased at the interface. Solder SnAgCuBi1.0 also varies in thickness of phases (Ag_3Sn and Cu_6Sn_5) located in the volume and quantity of solders projecting long-scallop skewer (Cu_6Sn_5 phase) of the interface to solders. These changes, microstructure refinement, can be attributed to greater number of particles Bi contained in Sn-rich areas.

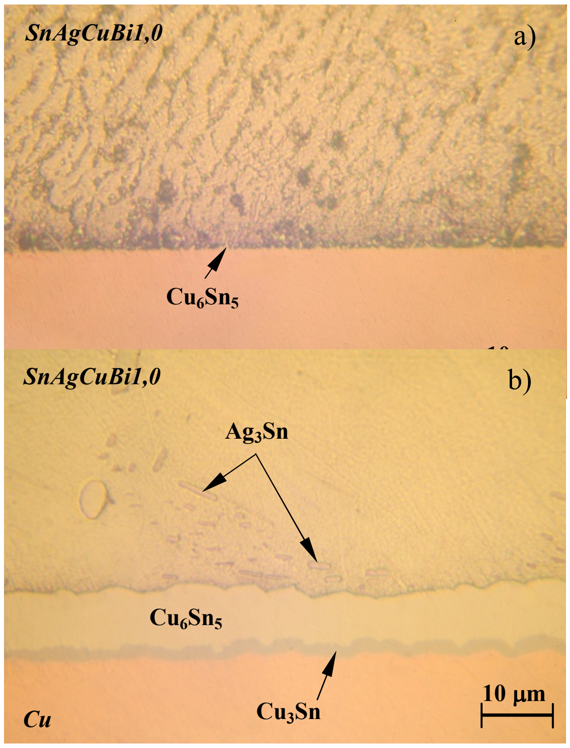

Fig. 3. Microstructure of the interfacial area of Cu-SnAg1.0Cu0.5Bi1.0 solder joint a) after soldering T = 255°C, t = 5 s, b) aged at 160°C for 360 h

The line EDX - microanalysis (Fig. 4) of joint Cu - SnAgCuBi1.0 confirms the close interface, which is made from phases Cu_3Sn and Cu_6Sn_5. This was confirmed by the unique occurrence of phases Ag_3Sn in gross IMC Cu_6Sn_5. As in the solder SnAgCuBi0.5 the presence of Bi precipitates in Sn-rich areas of the EDX microanalysis failed.

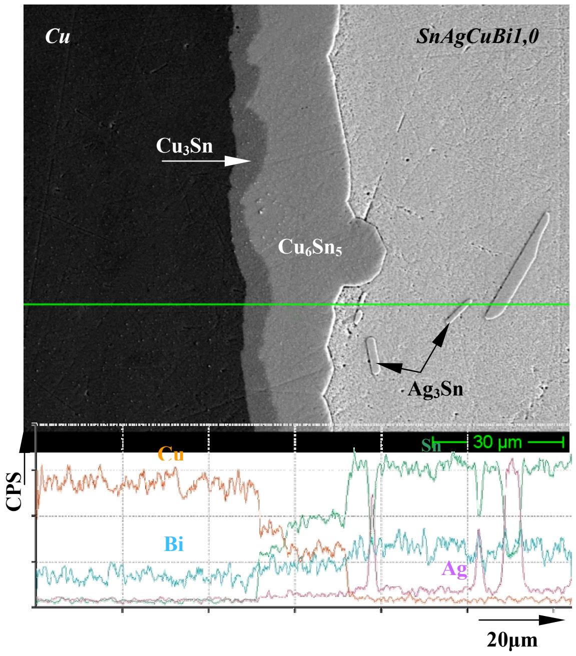

Fig. 4. Linear EDX microanalysis of Cu – SnAg1.0Cu0.5Bi1.0 solder joint interface aged at 160°C for 360 h

4. CONCLUSIONS

From the results of the study of interface the soldering lead-free joints it is clear that during the annealing (aging) services there are significant structural changes. Adding 1% Bi to system of alloy SnAgCu leads to refinement of grain size of intermetallic phases in the volume of solders and suppressing the growth layers of intermetallic phases at the interface in soldering joints and thus to improve the reliability of joints. Due to the low content (0.5 and 1.0%) of Bi alloys in the systems of SnAgCuBi presence of Bi precipitates was confirmed.

5. ACKNOWLEDGEMENTS

This paper was supported by project VEGA 1/0111/10.

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Circular interpolation deviations measurement on five axis machine tools with different structure

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Abstract

The article is focused on problematics of circular interpolation measurement on five axis CNC machine tools (five axis milling machine tool and five axis turning machine tool). Measurement was realized in one plane (XZ) or more planes (XY, YZ, XZ). NC program modifications for each measurement on machine tools are described in the next.The first part of the article is devoted into description of machine tools (milling machine tool DMG HSC 105 linear and turning machine tool DMG CTX Alpha 500), description of machine tools possibilities, movement characteristics and machine tool´s structures. In the next there is a description of measuring device Renishaw QC20-W Ballbar for circular interpolation measurement. The methods and procedures of measurement are also described as well as the NC code modifications for measurement and the reason of its modification. Measuring device is able to generate own NC codes for various machine tool´s operation system, however generated NC codes were not suitable for machine tools on which the experiments were realized. The last part of the article deals with an evaluation of experiments. Evaluation is based upon results earned from charts generated from Renishaw software. The results of circular interpolation deviations were compared with nominal values guaranteed by machine tool producer.

Keywords: Circular; Interpolation; Five axis; Machine tools.

1. INTRODUCTION

In machning technology accuracy is one of the keystone parameters. Many parameters affect achievable accuracy during the machining process. However the machinig parameters are affecting the process´ accuracy, the first and most important thing is the construction of a machine tool. Beside the toughness and rigidity of a machine frame, most accuracy defects are provided by moving parts of a machine tool. The movement is characterized by kinematic structure of machine tool and the accuracy is affected by type of drives and engines.

Measurements were performed on two CNC machine tools with different construction: Five axis milling machine tool DMG HSC 105 linear with XYZBC axes construction (*Fig. 1.*)

Fig. 1. DMG HSC 105 linear [1]

and turning machine tool DMG CTX APHA 500 with counter spindle and driven tools in cartridge (*Fig. 2.*).

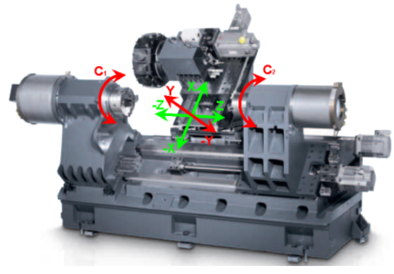

Fig. 2. DMG CTX Alpha 500 [1]

Used measurement device was QC20-W Ballbar system [1].

1.1. QC20-W Ballbar system

Renishaw`s QC20-W ballbar offers you the perfect solution. It`s the quickest, easiest and most effective way to monitor machine tool condition.

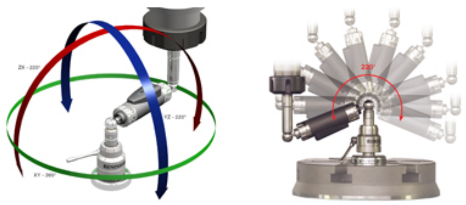

Fig. 3. QC20-W Ballbar system by Renishaw [2] [3]

The heart of the system is the ballbar itself, a very high accuracy, telescoping linear sensor with precision balls at each end. In use the balls are kinematically located between precision magnetic cups, one attached to the machine table and the other to the machine spindle or spindle housing.

This arrangement enables the ballbar to measure minute variations in radius as the machine follows a programmed circular path. The data collected is used to calculate overall measures of positioning accuracy (circularity, circular deviation) in accordance with international standards such as ISO 230-4 and ASME B5.54, or Renishaw`s own analysis reports. Data is displayed graphically as well as in numeric format to aid and support diagnosis [2].

2. EXPERIMENTAL

Measurement conditions for each measurement were as following: Air temperature was 20°C with deviation of 0.1°C, thermal coefficient of material expansion was 11.7 1/°C.

2.1. Measurement principle

Measurement was performed in following conditions:

Measurement device Ballbar was clamped between two magnetic devices, where one of them was clamped in spindle/ turret head and the oher one was clamped onto the table.

Software for Ballbar is equipped with NC programs for various machine tool structures on order of measurement, however the NC program written in Heidenhain code was not suitable either for lathe and milling machine tool due to different size of measured machine tools. There were necessary some changes because of the size of a machine tools and a structure of a milling machine tool, so the programs was used as a starting point to program own ones.

Spindle / turret head moved in circle / half circle path with diameter of 100mm / 150 mm depending on a machine tool. First values are valid for milling machine tool DMG HSC 105 linear, the second ones for lathe DMG CTX Alpha 500. Starting point of measurement was coincident with last point of measurement, i.e. the measurement was realized both for toward and backward movement.

The first measurement were performed on lathe DMG CTX Aplha 500 in XY plane according to a kinematic structure of a machine tool.

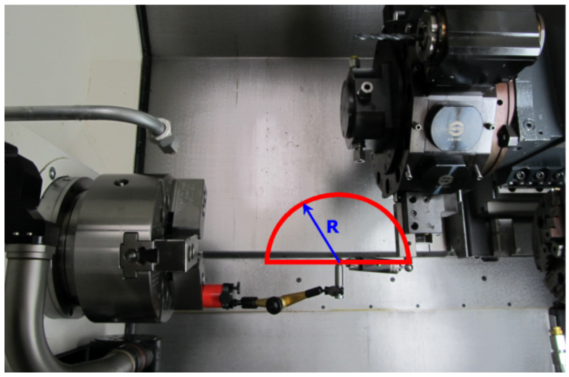

Fig. 4. Measurement principle on CTX Alpha 500

The second measurement was realized on machining centre, DMG HSC 105 linear in three planes XY, YZ and ZX. The reason, why for lathe was realized measurement in only one plane is that the other moves are smaller than the ballbar device is able to measure due to its own size. In HSC 105 linear was no size restriction, however for path shape there is a restriction according to a machine tool kinematic structure. The measurement were performed in circle path for plane XY and in half circle for planes YZ and XZ. Paths´ shapes were selected according to a machine tool´ kinematic structure XYZBC.

In XY plane the circle path has a diameter of 150 mm and half circles in two other planes has the same diameter..

3. MEASUREMENT RESULTS

Results are represented by charts showed in *Fig. 5 - Fig. 8*.

Following charts presented a circular interpolation accuracy of measured machine tools according to a masured plane.

In Fig.5- Fig.8 there is the interpolation accuracy for DMG HSC 108 linear for XY, YZ and XZ plane. Fig. 8 shows interpolation accuracy of CTX Alpha 500 in XY plane. Measured values were evaluated by Renishaw software for s QC20-W ballbar, the review and comparation with declared values are in conclusion.

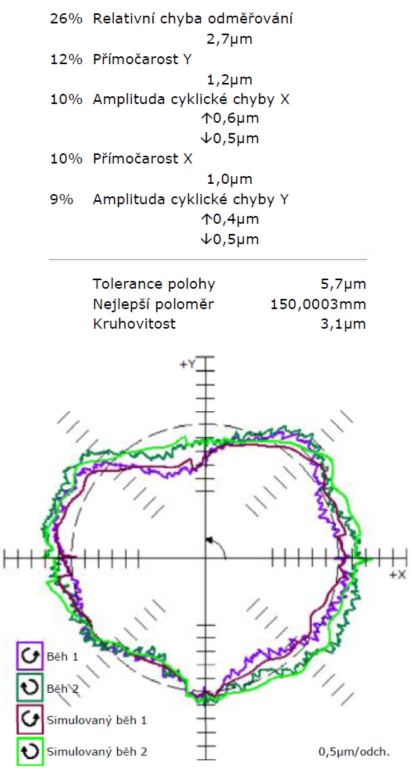

Fig. 5. DMG HSC 105 linear measurement results in the XY plane

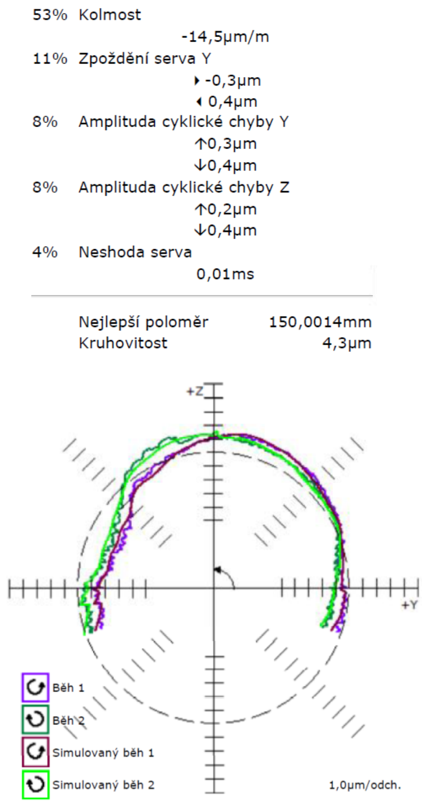

Fig. 6. DMG HSC 105 linear measurement results in the YZ plane

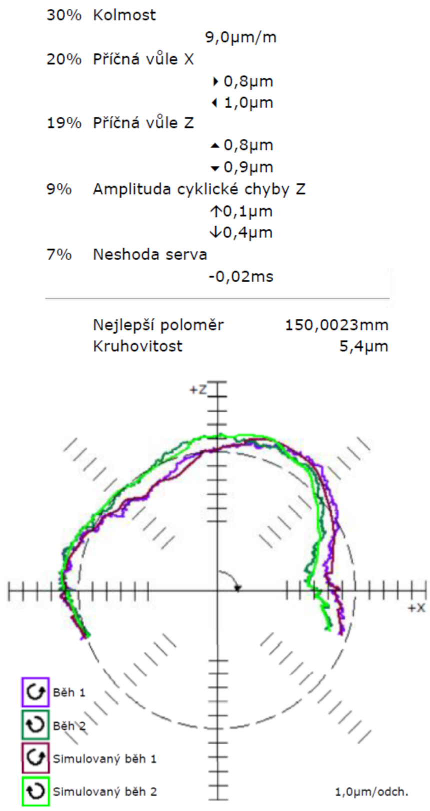

Fig. 7. DMG HSC 105 linear measurement results in the ZX plane

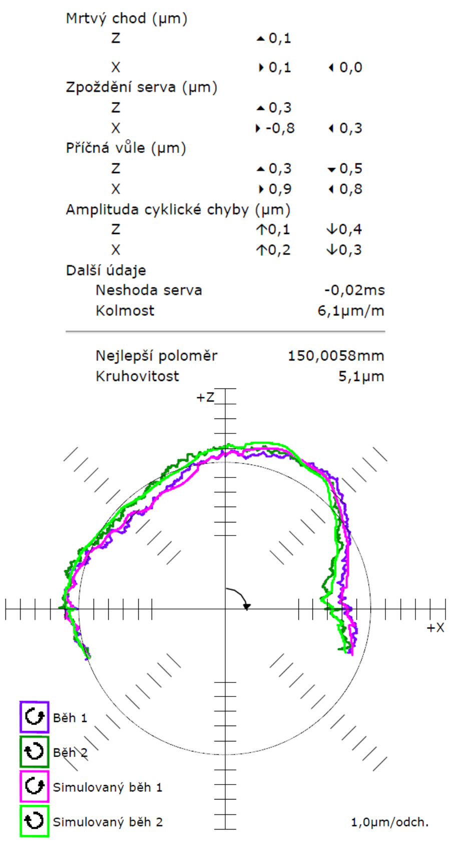

Fig. 8. DMG CTX Alpha measurement results in the XZ plane

4. CONCLUSION

In machine tools the kinematic structure has no significant effect on movement and positioning accuracy. The task is how this parameter is changing when the movements are combined with rotational moves.

Positioning accuracy of machine tools showed in charts (Fig.5 – Fig.8) in previous chapter declared that one year performance of machine tools has no significant effect on accuracy of positioning. This statement is based on comparison of masured values with values declared by producer on certificate of delivery. The maximum values of deviation for milling machine tool HSC105 linear deviations maximum measured value was 5,4 µm, decared value 8 µm. The conventional screwbar drive on turning machine declares a value of 10 µm positioning, measured value was 5,1µm.

Results from measurement can be used for machine deviation compensation by importing repair coefficient into the machines system.

5. ACKNOWLEDGEMENTS

Tento článok vznikol vďaka podpore v rámci
OP výskum a vývoj pre projekt
Centrum excelentnosti 5 -osového obrábania -
experimentálna báza pre high - tech výskum,
ITMS 26220120045, spolufinancovaný
zo zdrojov Európskeho fondu regionálneho rozvoja.

Európska únia
Európsky fond regionálneho rozvoja
Operačný program VÝSKUM a VÝVOJ

Podporujeme výskumné aktivity na Slovensku /
Projekt je spolufinancovaný zo zdrojov ES

This article has been realized under the
research and development OP for project
Centre of Excellence of Five axis Machining
Experimental Base for High Tech Research
ITMS 26220120045
co-financed by European Fund for Regional Development.

Európska únia
Európsky fond regionálneho rozvoja
Operačný program VÝSKUM a VÝVOJ

Supporting research activities in Slovakia/
Project is co-financed by European Community

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Deformations and surface layers properties evaluation of spun sheet metal parts

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Abstract

The paper presents results of experimental study focused on the analysis of strain distribution and effect of strain-hardening of the surface layers of sheet metal hollow parts produced by multi-pass conventional metal spinning. The thin sheets with 1 mm thickness, steel EN 10025-94 (ISO 630-80), were used for experimental study. The results of the study confirm minimal influence of the anisotropy of material on strain distribution and the relatively significant influence of the material anisotropy on the strain-hardening of the spun part's surface layers.

Keywords: Spinning; Strain; Strain-hardening; Anisotropy.

1. INTRODUCTION

The last decade has shown an increasing interest in a new class of forming processes known as Incremental Sheet Forming (ISF). A particular incremental sheet metal forming process which involves forming of axisymmetric hollow parts with advantageous surface layer properties is metal spinning [1], that incorporates conventional spinning, shear spinning and tube spinning [2].

All spinning techniques involve rotating a workpiece clamped onto a chuck while the spinning tools approach the workpiece and deform it to the required shape. As the tool is applied locally on the workpiece, the total forming forces are reduced significantly compared to conventional press forming. This increases the possibilities in terms of large reductions and change in shape with less complex tooling and also reduces the required load capacity and cost of the forming machine. Very significant feature of spinning is ability to produce components with high mechanical properties and smooth surface finish [3].

Although knowledge about the instant stresses, accumulated strains and damage evolution, which help to understand final properties of spun parts, have been developed by systematic investigation of the process using both experimental and theoretical techniques [4, 5 and other], several gaps still exist in the knowledge of spinning mechanics, mechanical and structural properties of surface and sub-surface layers of spun parts (residual stresses, microstructure) and more information we need for precise prediction of failure and cracks, too.

This study brings partial outcomes of a complex experimental research focused on the different aspects of the multi-pass conventional spinning. It gives answer on the question how the strain distribution and surface microhardness are influenced by material anisotropy.

2. METHODS AND MATERIALS

For production of hollow sheet metal parts, which shape and dimensions are demostrated in Figure 1 and listed in Table 1, have been used thin sheet, made out of carbon steel, defined in the standards EN 10025-94 (ISO 630-80). Chosen basic mechanical properties and facilities defining material plasticity (ultimate tensile strength (R_m), 0,2% offset yield strength ($R_{p0,2}$), elongation (A), medium value of anisotropy (r), planar anisotropy (Δr)) are listed in Table 2. The experimental samples have made by multi-pass conventional spinning under next conditions:

- feed ratio: $f = 0,8$,
- mandrel frequency of rotation: $n = 600$ min^{-1},
- number of passes: $p = 3$.

2.1. Strain distribution measurement

Strain distribution was obtained from a pattern of circles of known size (d = 2 mm) etched onto the blanks before spinning process. Elliptically deformed circles were measured after spinning and true major and true minor strains were calculated. Measurements were realised on optical microscope Zeiss BK 70 x 50. The strains in 0^o, 45^o and 90^o, refer to the sheet rolling direction, were studied.

2.2. Microhardness measurement

Mechanical properties of the spun parts surface layers were evaluated using microhardness measuring according to Vickers, method HV 0.025, under STN 42 0375, measured on INDETA Met 1100 device. The measurement was carried out in direction from part's surface to its depth on positions that are from aspect of hollow sheet parts production defined as critical – inter-stage spots of bottom to wall (I) and conic wall (II) (see Figure 1). Microhardness measurement in the surface and sub-surface area was carried out also on base material (BM). The measurement was applied in two directions – 0^o and 90^o refer to the rolling direction of the sheet.

3. RESULTS AND DISCUSSION

The results of true major and true minor strains measurement throughout formed sheet metal part are demostrated in Figure 2 and Figure 3. The places of measurement are shown in Figure 1 (the place of measurement "1" is located in the area close to the tailstock and the place of measurement "8" is located in the area close to the sheet edge).

Table 1. Formed part dimensions

D (mm)	***h*** (mm)	***h₁*** (mm)	***r***	***R***	***α*** (°)	***s*** (mm)
140	30	90	10	10	75	1

Table 2. Mechanical characteristics of experimantal material

R_m (MPa)	$R_{p0,2}$ (MPa)	$R_{p0,2}$ / R_m (-)	A_5 (%)	r_s (-)	Δr (-)	n (-)	A_{sh} (-)
340	235	0.69	26	1.174	0.34	0.28	27.38

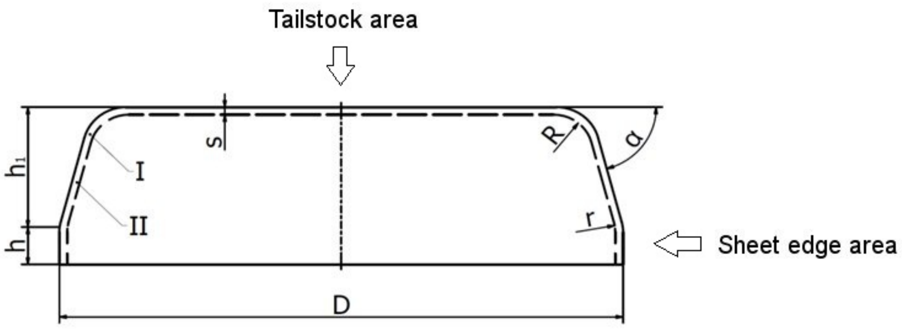

Fig. 1. Experimental sample
I – bottom-wall section of part, II – conic wall section of part

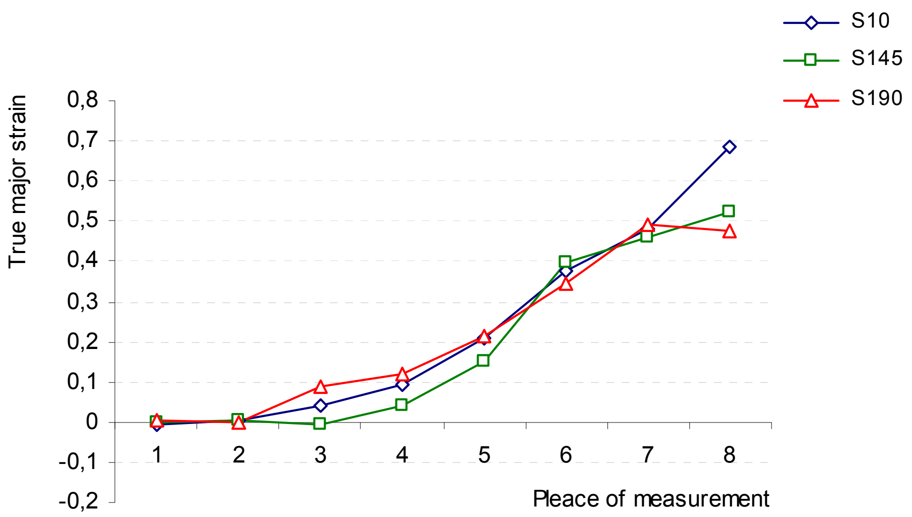

Fig. 2. Distribution of true major strains φ_1
(S10 – 0°, S145 – 45° and S190 – 90° refer to the rolling direction of the sheet)

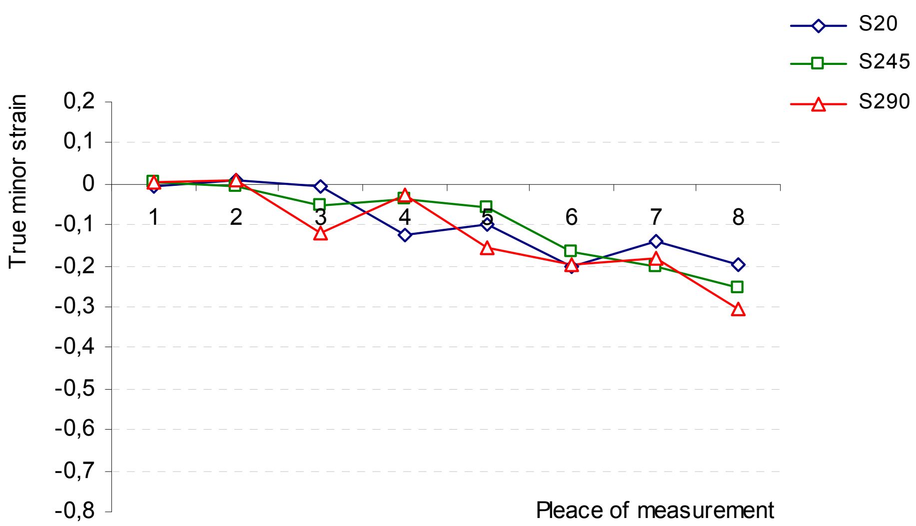

Fig. 3. Distribution of true minor strains φ_2
(S20 – 0°, S245 – 45° and S290 – 90° refer to the rolling direction of the sheet

Graphic evaluation of microhardness values of sample's surface layer, made by metal spinning, in positions I and II, under consideration of material rolling direction, is shown in Figure 4. Measured and calculated values for base material are listed in Table 3.

Table 3. Microhardness values of surface layer – base material

Depth of measure (µm)	***5***	***10***	***15***	***20***	***25***	***Mean average***
$HV_{BM/0}$	101.9	101.8	100.2	99.3	98.9	101
$HV_{BM/90}$	101.7	99.4	99.2	98.6	98	101.14

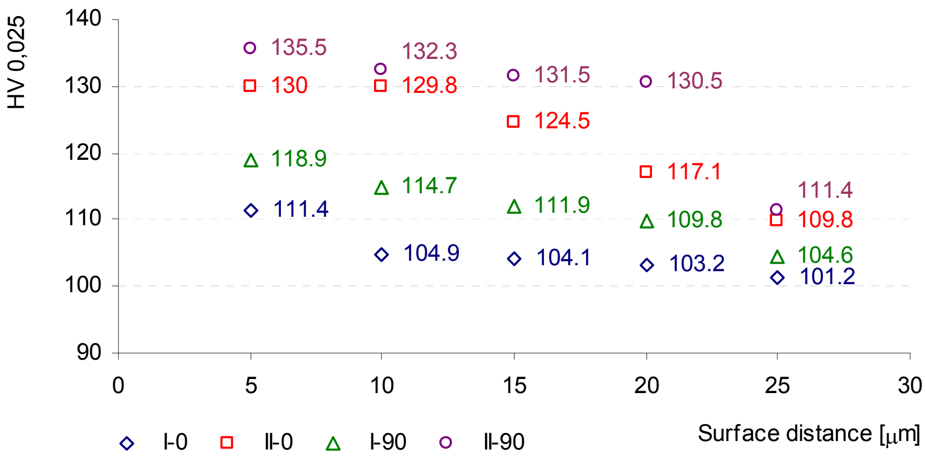

Fig. 4. Progress of microhardness values in surface layer in position I and II, in direction 0°and 90° refer to the rolling of the sheet

4. CONCLUSIONS

The results of carried out experiments lead to the next conclusions:

- Comparison of the strains in directions – 0°, 45°, 90° refer to the rolling direction of the sheet comfirmed the assumption about minimal influence of material anisotropy in the spinning process. For metal spinning process is typical deformation only in small (local) volume of material.
- Microhardness of surface layers is influenced by initial direction of material rolling. In the both measured places on the part we can see higher strain-hardening in the direction 90° refer to the rolling of the sheet.

5. ACKNOWLEDGEMENTS

The authors thank the MESRS SR for support of the project „*Multivariate optimization of the metal spinning processes – research and development*“(7th FP EU MANUNET 2008-SK-001), in which the contribution was made.

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WELDING SIMULATOR – A TOOL FOR NOVICE WELDER

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Abstract

Welding is a manufacturing process that is necessary for industry and can be found in almost every company all over the world. It is a process that requires training and specific skill development. As such, training systems for welders have been around almost as long as the practice of welding itself. These training technologies range from the very early mechanical welder trainers, to more complex mechanical systems, and subsequently to computer based training systems. Article deals with the welding simulator as an aid in training novice welders. The first part of the experiment involved students attending a training program for welding simulator at first, and subsequently simulation with default parameters without visual guide marks (open mode). In the second part of the experiment, each student performed three real control welds with MAG technology, whereby the best samples were chosen for visual inspection and the visual inspection report was carried out. The goal of the paper was to emphasise the importance of acquiring basic manual skills even before the real welding, and also to point out the advantages of welding simulators usage in the training process. Here can be mentioned primarily the consumables cost reduction.

Keywords: Welding simulator; Training; Arc welding; Welding parameters.

1. INTRODUCTION

Education and training in particular skills of welding is now a key process to address the labor shortage that exists in this area. This education is very expensive what is negatively reflected in the overall price of the training. Nowadays, people are looking for new ways to accelerate the learning process, reduce costs and improve the quality of training. Many companies have a shortage of skilled welders. Simulators are a step to improve the image of welding using innovative technologies. There are many companies dealing with simulators on the market. The biggest advantages of simulators are cost savings for materials, clean workplaces. The newest simulator on the market is a simulator Virtual Welding 2010 from Fronius company. Virtual Welding (VW) provides a virtual environment for students to become accustomed to the specific hand movements and sounds during the arc welding process. It works on the basis of monitoring. VW uses a magnetic system. The system also remembers the slightest movement of the hand which is displayed on the screen or in 3D glasses on the welder's helmet. Under the welded parts there is a magnetic sensor that produces a spherical magnetic field [1].

2. METHODS

The task of the experiment was to evaluate the effectiveness of the simulator as welding equipment in training novice welders. From the collected data we subsequently acquired trainee's manual skills. The main benchmark was a visual inspection of the produced welds. The first part of the experimental program was conducted on a portable welding - Virtual Welding Simulator lent from Fronius Trnava. To evaluate the effectiveness of welding simulator, an experimental sample of five people was created - novice welders who have not experienced the welding process, only from a theoretical point of view.

At the beginning of the simulation it was necessary to create a welding program. The following step was to adjust the welding parameters such as type and position of the welding. Afterwards, we selected the fillet weld in position PB. VW simulates MAG welding. Training mode is divided into two parts (Fig. 1), training and simulation. During the training it is necessary to set particular percents of success. Speed and the stick out were set at 80%, position of the welding gun was taken into consideration and the success threshold was set at 75%. Each participant had 3 times in a row reach the border which is up to 800 points in the first and second trial and 750 points in the third trial.

Fig. 1. Training mode

Training consists of 3 levels and the simulator monitors specific welding parameters:

1. speed
2. speed + stick out
3. speed + stick out + position of the welding gun.

3. RESULTS

Five graduates participated in the training and simulation. Welding speed parameter was the easiest parameter to obtain. Maximum time - 18 minutes was necessary for trainees to achieve the required criteria. Their results such as duration, the highest number of achieved points and the number of attempts at welding speed parameter are shown in Fig. 2. This level was passed relatively quickly and they were ready to move on to the next level where they had to continue with the stick out parameter.

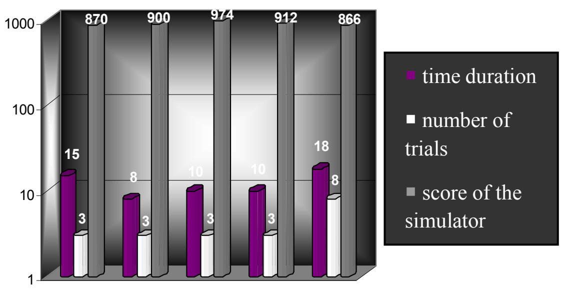

Fig. 2. Results graduates – welding speed

The second level of the training program was a little bit more difficult for trainees in comparison with the first task as it reflected in the number of repetitions of exercise. Only one trainee mastered the exercises three times in a row at the beginning of training. Other trainees were in the range 6 to 29 attempts to achieve the desired level.

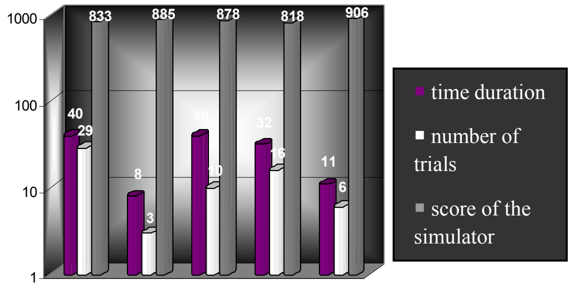

Fig. 3. Results graduates - speed + stick out

As we expected, the biggest problem in training mode had graduates in the third level, where they had to cope with all three parameters. Duration, number of attempts and the success of graduates are shown in Fig 4.

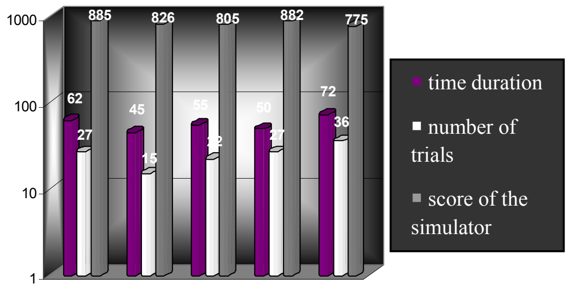

Fig. 4. Results graduates - speed + stick out + position of the welding gun

The simulation was evaluated by three achieved results that are displayed in Tab. 1. Welding simulator created after all virtual welds evaluation of simulation as shown in Fig. 5. The simulator could not evaluate all individual welds because the graduates proceeded too fast so the welding speed was too high.

Tab. 1. Results of the simulation

	ATTEMPTS		
GRADUATES	1	2	3
SAMPLE B	1890	1970	2035
SAMPLE G	1477	1752	2010
SAMPLE K	1216	1701	1930
SAMPLE M	1874	1702	1850
SAMPLE J	1649	1951	2038

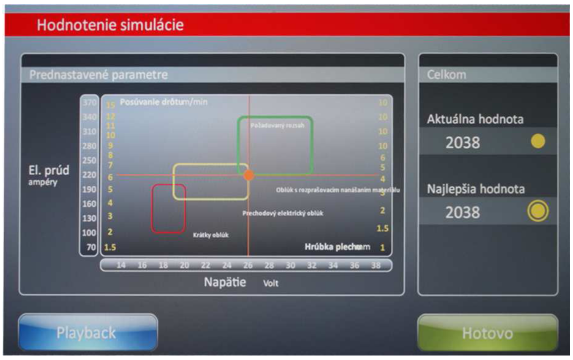

Fig. 5. Evaluation of simulation

In the experiment we used low carbon steel sheets, with a thickness 5 mm. We used a GMAW welding technology. Fillet welds (FW) were created in position PB. Each graduate made three welds; one of them was chosen and subsequently evaluated by visual examination. Chemical composition of the material and mechanical properties are listed in Tab. 2.

Tab. 2. Chemical composition, mechanical properties

CHEMICAL COMPOSITION				
MATERIAL S235JRG2	C	P	S	N
	max. 0, 17	max. 0, 045	max. 0, 045	max. 0, 009
MECHANICAL PROPERTIES				
MATERIAL S235JRG2	Re [MPa]	Rm [MPa]	A [%]	
	235 - 225	340 - 470	24	

Welding was carried out at Faculty of Materials Science and Technology in Trnava.We used the ForMIG 249th welder. Welding parameters are given in Tab. 3.

Tab. 3. Welding parameters

Welding wire diameter [mm]	1,0
Welding current [A]	110
Wire feed speed [m/min]	3,8
Protective gas	85% Ar, 18% CO_2

To determine the quality of welds, the samples were subjected to visual inspection. The test was carried out according to relevant standards such as BS EN ISO 6520-1, EN ISO 5817 and BS EN ISO 970th. Out of the three samples, only the best ones were selected for visual inspection, in particular B2, G2, K1, M2 and J2. The Cambridge scale (Fig. 6), Inox (Fig. 7) and the scale-WAC (Fig. 8) were used for quality control of welded joints.

Fig. 6. The Cambridge scale

Fig. 7. Inox

Fig. 8. The scale-WAC

Sample B2 (Fig. 9) was evaluated as an excessive asymmetry of fillet which may be due to inaccuracy of the welding gun.

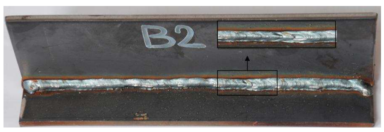

Fig. 9. Sample B2

Sample G2 (Fig. 10) had asymmetric fillet weld which could have been caused by the instability of leading the welding gun.

Fig. 10. Sample G2

Sample K1 (Fig. 11) exhibited the insufficient throat thickness as well as the excessive throat thickness defects.

Fig. 11. Sample K1

Increased porosity was observed at the surface of the welded joints (Fig. 12). We suppose that pore formation was caused by a long arc, or an excessive stick out.

Fig. 12. Sample J2

Sample M2 (Fig. 13) was marked with a lack of fusion which could have occurred during high speed welding or could have been caused by incorrect position of welding gun and welder's skill imperfection.

Fig. 13. Sample M2

Visual examination revealed that none of the welds was satisfactory. We suppose it's probably due to lack of experience of graduates. Spatter was one of the most common defects. It could have been caused by either the long arc or the excessive stick out. Also lack of penetration was occasionally observed, which may have been caused by inaccuracy of leading the welding gun.

4. DISCUSSION

During the experiment it was observed that welding simulator had its advantages and also disadvantages. Welding is virtual and its inevitable part is 3D glasses that are built in the helmet. The main problem of welding helmets was a correct alignment of the virtual glasses, which in the case of small displacements can cause inaccuracies in the display, or a blurred vision of a trainee. We can see this phenomenon especially when using the bifocal glasses. It is very difficult to set up correct alignment of the helmet. In such cases it is preferable to use contact lenses in terms of safety and practicability.

There also have been problems such as:
- foggy glasses,
- helmets went off in a long term operation of the equipment,
- necessity of the system reboot because of the slowdown after a certain time,
- lit arc and thus poor visibility of the welding pool,
- unrealistic display of the welding pool.

Following consultation with a welding instructor showed that trainees using the simulator did better than students at school without using a simulator.

5. CONCLUSION

From the obtained results it is obvious that welding simulator is effective for novice welders, since trainees rapidly acquire basic skills such as the position of the welding gun, welding speed and the stick out. The welders with many years of experience do not prefer welding simulator because they have manual skills gained during their practice. In our case, it can be mentioned that the use of simulators did not achieve the maximum efficiency. According to the manufacturer, the prescribed time for the training of one person is 60 hours. Our training samples were completed just in a fraction of that time.

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Sensitivity verification of the diagnostics NDT methods

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Abstract

Non-destructive control of welded joints (NDT) is now a tool to assess the quality of welded structures. Compared with the destructive testing of welds allows the product to remain unchanged in their use. The presence of defects in welded joints is nearly inseparable part of them. Diagnostic neglect or incorrect diagnosis application of NDT methods leading to poor detection of defects, which may in time lead to unwanted accidents of welded structures. Individual non-destructive methods often provide different options present disclosure errors. Comparison of results may lead to different degrees by the inclusion of product quality. This paper describes a comparison of modern computer-aided ultrasound techniques, TOFD and Phased Array with radiography method on samples of welded joints with a thickness of 25 and 31 mm. Radiography materials with higher wall thickness leads to a weakening of the intensity of radiation and subsequent impaired detection of errors present. For the next experiment, we expect greater efficiency distinctiveness of errors in the application of ultrasonic techniques, TOFD and Phased Array.

Keywords: Non-destructive testing; Welded structures; Defects; TOFD; Phased Array.

1. INTRODUCTION

The possibility of the weld defect presence detection is provided thanks to a wide range of non-destructive methods. The new NDT methods are capable of obtaining the full view of the shape, size and position of the defect in examined material, whereas in the standard NDT methods it is necessary to compare the results with reference standards and dependent on user skills. To designation of the residual lifetime of the welded constructions, it is necessary to have complex knowledge about present defects [1]. These data can be obtained using computer-aided ultrasonic inspection techniques TOFD and Phased Array. The main objective was to compare the results of weld joints quality control using above mentioned methods on samples having defects produced on purpose. The difference in measurements obtained by both control methods leads to different determination of residual lifetime of welded construction containing the defects.

2. METHODS AND MATERIALS USED FOR RESEARCH

TOFD is an ultrasonic method allowing the detection of cracks dimensions and their position in relation to the surface of the material. The method is based on ultrasonic wave diffraction on defect peaks. Two probes are used for detection. The first probe works as a transmitter whereas the second one works as the receiver. The position of both probes is registered by the encoder. Vertical dimension of the crack is calculated by the principle of the Pythagorean Theorem. The data used for calculation are the time difference between arriving waves reflected from the upper and lower edge of the crack, velocity of the ultrasound propagation in examined material and the distance between the probes [2].

Phased Array (PA) method use ultrasonic probes with maximum of 126 array elements for testing, that allows sound distribution without necessity of probe movement in the perpendicular direction of the weld joint axis on the material surface. The phased transducer excitation enables ultrasonic beam deflection, focus and sound distribution by contemporary transmission of the beam in the angles of 45°, 60° a 70°. The detection of various oriented cracks was very difficult using conventional ultrasonic method but the PA method brings high accuracy into the measurement [2].

The material used in experimental was S355 steel sheet. Two samples were welded by GMAW technology in CO_2 protective gas. A butt weld of double V-shaped groove was performed on both samples however the first sample (Sample 1) was 25 mm in thickness and the second one (Sample 2) was 31 mm thick welded as single V-shaped butt weld. In both weld joints were defects produced on purpose in order to compare the sensitivity of current High-tech ultrasonic methods (TOFD and Phased Array) and radiography method.

Omniscan device with the probes of 5 MHz frequency were used for the control carried out by TOFD method, whereby the distance between both probes in case of Sample 1 was set to 60mm and 70 mm in case of Sample 2. Sample 1 was analysed three times with the parameters of 34, 40 and 46 dB. Figure 1 shows the experimental set-up of probes and wave path through the sample. The parameters in case of Sample 2 TOFD measurement were 45, 51 and 57 dB.

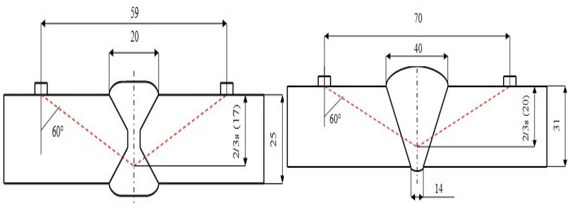

Fig. 1. Set-up of probes for TOFD testing

The probe containing 16 transducers of 2 MHz was used within the Phased Array method. The sound was distributed through the material in the angle range from 45° to 70° in dependence on probe position from the weld axis. The sensitivity of this method was calibrated on reference standard with the hole of 1.5 mm in diameter and 21 mm in depth for the echo size with the maximum of 80% screen appearance (FSH). Figure 2 shows the experimental set-up of the probe in relation to the weld position.

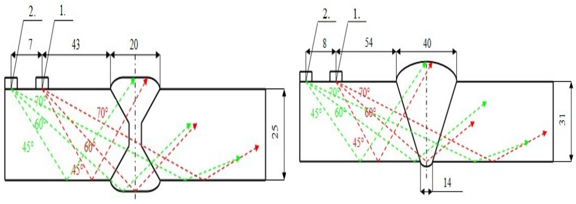

Fig. 2. The experimental set-up for Phased Array method

3. RESULTS AND ACHIEVEMENTS

A lot of defects observed in Sample 1 were situated in the root section (figure 3) of the weld joint (11 to 14 mm) since as it is double-sided V-shaped weld joint. The record also provides the information on dimensions of defects obtainable by the TOFD detection method.

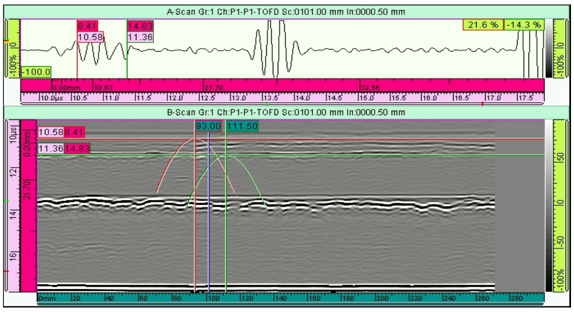

Fig. 3. TOFD record of Sample 1

Figure 4 demonstrates defects and measurements of their dimensions on Sample 2. All defects were observed at the back wall of the sample, what represents the root section of the weld in case of single-side V-shaped butt weld.

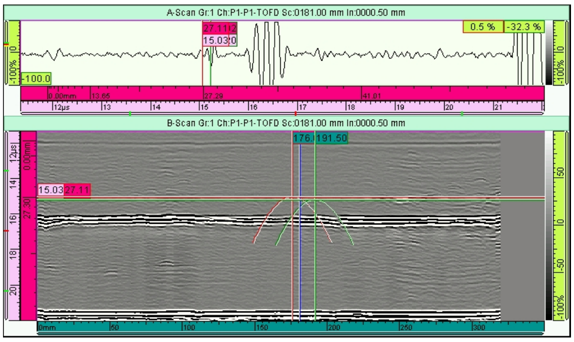

Fig. 4. TOFD record of Sample 2

Phased Array control measurement of Sample 1 is shown in figure 5 together with the measurement of defect size.

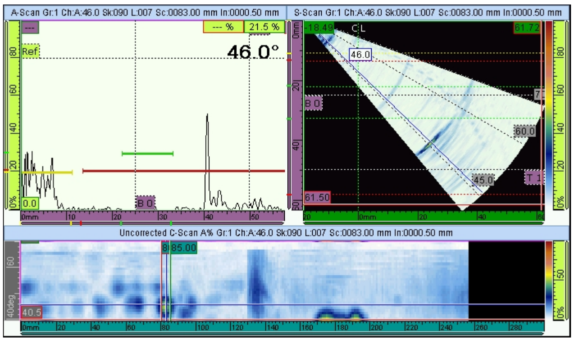

Fig. 5. Phased Array Record of Sample 1

Defects presented in Sample 2 are shown in figure 6. Based on the measurement results were defects identified as poruses and their clusters. These defects are not considered as the fracture initiators and their size do not influence directly residual lifetime of welded construction. That is why the Sample 2 absents the measured values in Table 2 as well as the residual lifetime calculations.

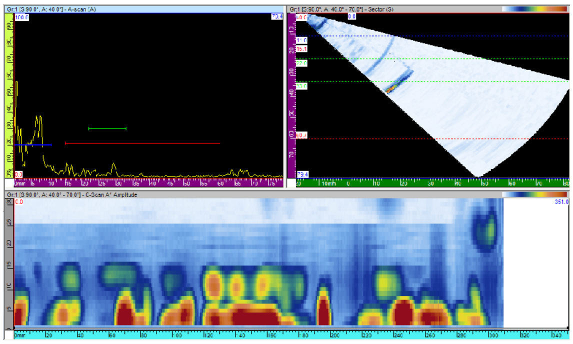

Fig. 6. Phased Array record of Sample 2

The particular ultrasonic methods offered slightly different values in measurements of the defects. The defects dimensions measured on Sample 1 and Sample 2 by both TOFD and Phased Array methods are provided in Table 1 and Table 2.

Table 1. Defects dimensions measured in Sample 1

No. of error	TOFD		Phased Array	
	Error length [mm]	Error depth [mm]	Error length [mm]	Error depth [mm]
1.	18.50	6.43	5	9.50
2.	297	3.75	26.50	2.57

Table 2. Defects dimensions measured in Sample 2

No. of error	TOFD		Phased Array	
	Error length [mm]	Error depth [mm]	Error length [mm]	Error depth [mm]
1.	23	1.03	x	x
2.	15.50	0.81	x	x
3.	40.50	1.01	x	x

The ultrasonic methods of TOFD and Phased Array currently belong to the new methods of non-destructive testing verified by the practice. Based on the material, its thickness and shape, it is desirable to verify the measurements results especially the reproducibility of tests and sensitivity for particular application. The measurements results of conventional radiographic method for both Sample 1 and Sample 2 are provided in Figure 7 and Figure 8.

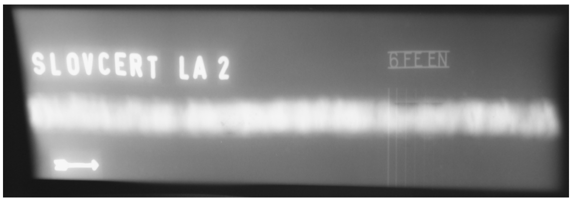

Fig. 7. Record of weld sample No. 1 by radiography method

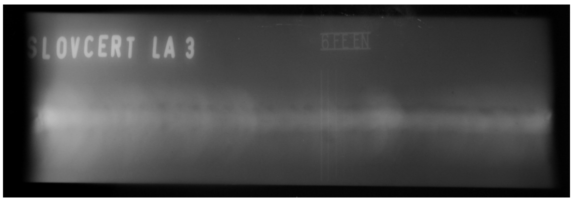

Fig. 8. Record of weld sample No. 2 by radiography method

According to the radiography control results it can be claimed, that in case of the Sample 1 weren't observed any distinct defects in weld joint, except for the face undercut defects detected by previously used visual inspection. The record of Sample 2 did not clearly identify the presence of defects what indicates the possible acceptance of weld joint from the quality point of view.

Based on determined dimensions and the defects type present in the weld joints, it is possible to calculate residual lifetime of welded construction during the fatigue crack growth incipient from these defects (material S355, Re = 345 MPa, KIC = 58 MPa$\sqrt{m}$). The number of cycles till the construction failure (ΔN) in Sample 1 is very different due to the dimensions of the 2nd defect (Table 1) measured by both Phase Array and TOFD methods. The immediate defect size of 2.57 mm observed by Phased Array method corresponds with 1.186 $\times 10^6$ cycles. The measurement of the same defect by TOFD method showed 3.75 mm in depth what correspond to 780460 cycles till the construction failure. Defect No.1 present in Sample 1 showed dimensions exceeding the defect length in the lifetime end. Therefore the calculations of cycle's number difference were not perfected. Figure 9 demonstrates the immediate sizes of determined defects (a_{imm}), the sizes of defects before the end of lifetime (a_{lt}) and sizes of defects for remaining life (a_{rl}).

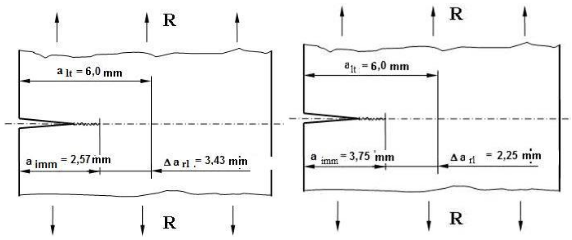

Fig. 9. Crack growing illustration

Figure 10 and Figure 11 illustrate the stress direction and the defects location of Sample 1 welded joint.

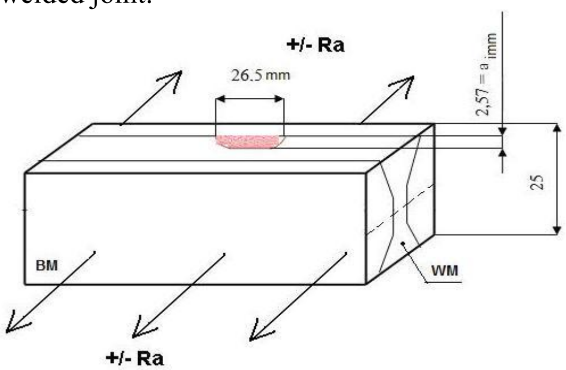

Fig. 10. Illustration of defect No.2 (PA) for lifetime calculation

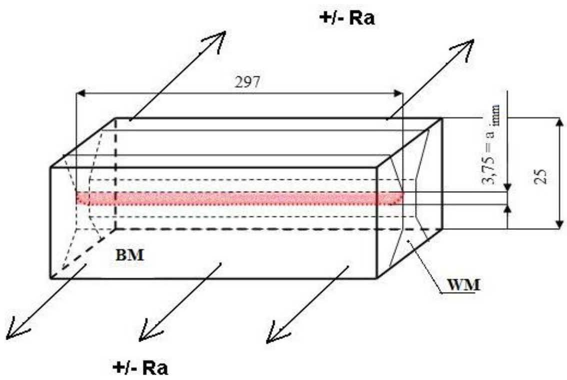

Fig. 11. Illustration of defect No.2 (TOFD) for lifetime calculation

4. CONCLUSIONS

Regarding the comparison of residual lifetime calculations of welded construction it can be concluded that the defect detected by the TOFD revealed less cycles to the failure than Phased Array. The limit state of the construction failure could be reached untimely when using the Phased Array method showing the higher number of cycles and therefore it is recommended to use TOFD method showing less cycles from the safety point of view. These differences in cycle number are caused by the measurements in different angles of ultrasound waves according to particular method. The reliability of each method is still an important subject of research, demanding a lot of testing and evaluation from manufacturer's side.

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THE INFLUENCE OF CORE MATERIALS CONTENT ON TECHNOLOGICAL PROPERTIES OF UNIVERSAL BENTONITE MOULDING MATERIALS

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Abstract

The paper deals with influence of core materials content on bentonite moulding materials. The experiments evauluated the influence of increasing core sand content on mechanical properties, permeability, humidity and lifetime of bentonite moulding materials. It was established that increasing core sand content decreases the lifetime of bentonite moulding material.

Keywords: Core materials; Universal moulding materials; Bentonite.

1. INTRODUCTION

The technical development in foundry production improves many used technologies. The practical effects of these improvments are higher castings quality and lower probability of casting defects. To achieve this the moulding material quality is very important. Modern production systems like Disa or Haflinger use universal bentonite moulding material, which is continually reused in production cycle. However the moulding material must be improved by new bentonite addition according to number of cycles and its degradation. Also new sand is added into moulding material. It is necessary to know the properties like humidity and permeability during its preparation for economic use of new binder and sand. These can be established continuously by measurement devices located in workshop for moulding material preparation near mixer to control the improvment of moulding material. The great number of moulding material re-using cycles influences their technological properties by core material. The core material remains in universal moulding material as broken parts of cores at shakeout tables, shakeout devices, etc.. These parts of cores can cause decreasing of some technological properties especially during large batch production of casing type castings. The measurements of humidity and permeability are not sufficient for production of such castings also mechanical properties of universal bentonite moulding material must be measured. The moulding material properties are characterized by physical, chemical and technological parameters.

2. METHODS AND MATERIALS

The bentonite moulding materials are most used moulding materials for moulds used for cast iron castings production.

The components and properties of universal bentonite material used in experiments are in Table 1. It was prepared by intensive mixer TECHNICAL SPM 70. The moulding material was sampled during its transport (by conveyor belt) before moulding. For its final conditioning laboratory vertical wheel batch type muller MK was used. The humidity of moulding material was adjusted before experimental measurements to achieve required compactibility. The compactibility required for this experiments was determined as 35 %. The used weight of moulding material into laboratory vertical wheel batch type muller was 10 kg.

Table 1. Basic components of universal bentonite moulding material

Universal bentonite moulding material			
Binder		Sand	
KERIBENT C30 (bentonite mixture)		Šajdíkové Humence SH34 (d_{50} = 0,22 mm)	
Adsorption of methylene blue	min. 240	SiO_2 content	98,20%
Humidity min. (%)	6	Fe_2O_3 content	0,15%
Humidity max. (%)	12	Carbonates	max. 0,15%
Compressive strength (kPa)	min. 100	Content of particles below 20 μm	max. 0,20%
Graphite content (calculated) (%)	min. 3	Refractoriness	min. 1400ºC
Bentonite component content (%)	77,1	Humidity	max. 0,2%

Cores produced by various methods were used during experiments. Sand Šajdíkové Humence SH33 (d_{50} = 0,27 mm) from Kerkosand a.s. was used for coremaking

Fig. 1. Devices for moulding material strength properties measurement LRU-D and permaebility measurement LPiR-D [3]

The 10, 20, 30 and 50 wt. % of core material were added to moulding material. After each addition of core material the humidity of moulding material was adjusted to achieve required compactibility 35 %. On Fig. 1 can be seen devices for moulding material strength properties measurement LRU-D and permeability measurement LPiR-D used for experimental measurements. The test specimens were cylinders with diameter 50 and heigth 50 mm, made by sand rammer HVD-1 with impact energy 9,81 J. They were used to determine the dependence of moulding material properties on core material content. The measured properties were mechanical properties - compression strength, splitting strength an physical property – peremability. The dependence of compression strength of moulding material on core material content from 0% to 50% without addition of new bentonite can be seen on Fig. 2. The dependence of compression strength on humidity of moulding sand samples can be seen on Fig. 2. It can be concluded that lifetime of bentonite moulding material is determined by minimal water content. The influence of core material content on decreasing of moulding material humidity is also obvious. It can be said, that core materials used for Cold Box (amine) have similar effect on moulding material as addition of new sand. The optimal humidity to achieve required mechanical and technological properties of moulding sands using modern bentonite mixtures is in range 2,4 - 3,2 % as can be seen on Figs. 2, 3, 4. The humidity below 2,3% causes decreasing of mechanical properties and permeability and subsequently causes defects of produced moulds.

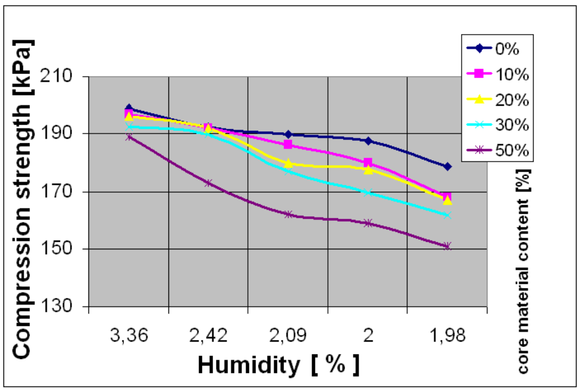

Fig. 2. The dependence of compression strength on humidity of moulding sand samples

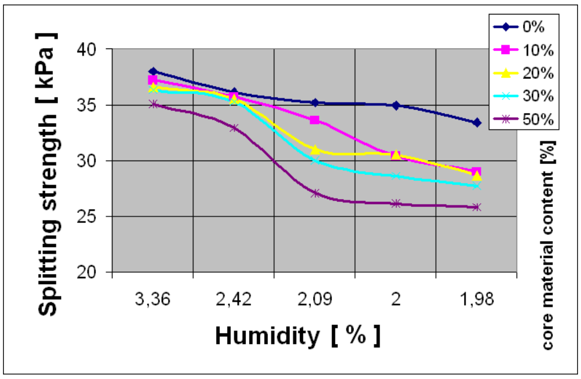

Fig. 3. The dependence of splitting strength on humidity of moulding sand samples

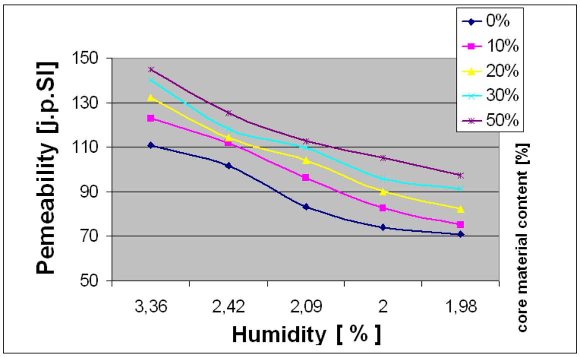

Fig. 4. The dependence of permeability on humidity of moulding sand samples

Thus casting defects can occur. Because of this moulding material must be improved by new binder. For this experiment was determined 10 % new binder (bentonite mixture) of core material added.

The obtained results can be seen on Figs. 5 and 6. The addition of new binder improves mechanical properties of moulding materails. To improve technological properties of moulding material carbon content additive (graphite powder 3%) was added with bentonite.

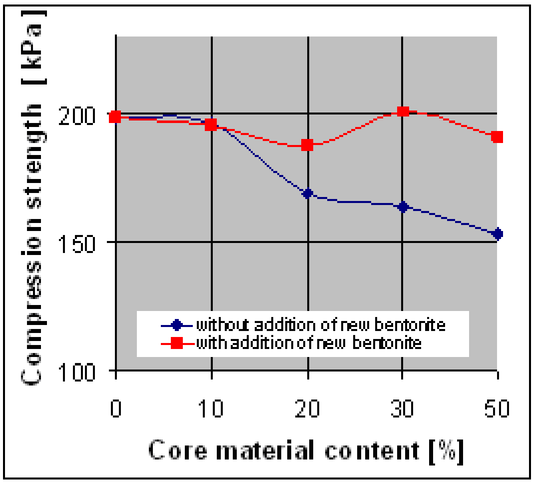

Fig. 5. The dependence of moulding material compression strength on core material content

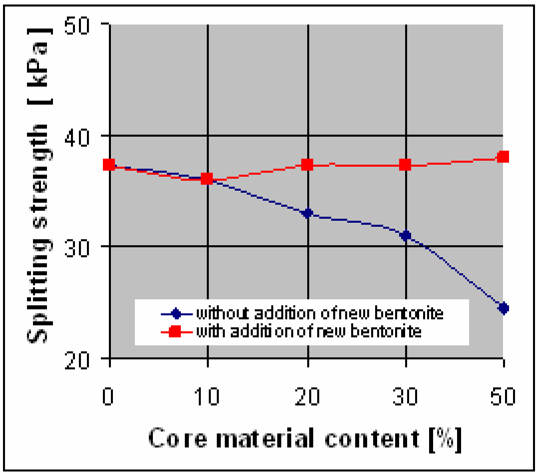

Fig. 6. The dependence of moulding material splitting strength on core material content

3. RESULTS AND ACHIEVEMENTS

The strength properties of moulding material depend on its humidity and compatibility. The measurements of compression strength established that increasing content of core material cause decreasing of compression strength. The content of 50 % core material in moulding material decrease the compression strength about 50 kPa as can be seen on Fig. 5. The addition of new binder (mixed bentonite with 10% content) did not changed compression strength significantly as can be seen on Fig. 5.

Fig. 3 shows dependence of splitting strength on core material content. From the splitting strength measurements can be concluded that increasing core material content decreases splitting strength. 50 % core material content in moulding material decreases splitting strength by 13,4 kPa. This decrease can be eliminated and original values obtained by adding of 10 % bentonite mixture. Thus can be concluded that core material content influences mechanical properties of universal moulding material. The decreasing of mechanical properties can be caused by lower binder content in universal moulding material. The increasing core material content causes decreasing of its humidity and lifetime. Thus the mechanical properties (compression strength Fig. 2, splitting strength Fig. 3) and permeability of moulding material (Fig.4) decrease.

The measurements of moulding material permeability established that addition of core material increases its permeability, due to decreasing binder content as can be seen on Fig. 4. The addition of 10 % new mixed bentonite caused smaller increasing at same core material content. Thus can be concluded that binder content has great influence on moulding material permeability.

4. CONCLUSIONS

The obtained results enable to conclude, that presence of core sands significantly influence properties of universal bentonite moulding material. This influence can be observed on strength properties of moulding material (compression strength, splitting strength). The increasing content of core material decreases strength properties of moulding material. It was also established that addition of new binder (mixed bentonite) into moulding material did not change moulding material`s mechanical properties and permeability significantly. From this can be concluded that it is necessary to monitor of technological properties during mouldmaking. It can be carried out by mechanical properties and permeability measurements. Subsequently the new binder and water is added into moulding material according to previously measured values.

5. ACKNOWLEDGEMENTS

Authors wish to thank for VEGA funding agency 1/0383/10 grant financial support.

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The optimalization of the technological parameters of precision die forging in closed dies

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Abstract

The paper deals with the research on the optimalization of the technological parameters of precision die forging in closed die with the aim to achieve high dimensional accuracy and surface quality of drop forgings. The research has been applied on spur gears with a hub. This type of mechanical part has been chosen because of the wide using in machine industry and suitable shape of drop forging for the use in precision die forging in closed die in practice. Manufacturing of drop forging of spur gear consists of the single forming operation – precision die forging in closed die from ring billet. Case hardening steel STN 41 4220 has been chosen as a material of drop forging. Computer simulation is useful solution for prediction of the course of process and material behaviour in die cavity. Computer simulation has been used for the optimalization of billet dimensions and the shape of die cavity in closed die forging. Suitability of material flow in die cavity, effective plastic strain and temperature of drop forging have been evaluated with the help of simulation software Simufact.forming. To meet all the requirements on precision of drop forgings in international competition it is necessary to take into consideration optimalization of technological parameters with the use of computer simulation.

Key words: Precision die forging; Closed die; Spur gear; Computer simulation.

1. INTRODUCTION

Manufacturing processes as a product in the area of the production of drop forgings with die forging must be still analyzed and improved to meet all customers requirements, environmental legislation and international competition. Production of drop forgings by the precision die forging is the main area of research and development within the frame of advanced methods of the production of drop forgings. Design and production of drop forgings, which vary minimally from the shape of the part for the assembly at the optimization of production costs and production times is the main aim of the precision die forging technology.

Precision die forging can be used for the manufacturing of simple or complex drop forgings with high precision. They can be divided into drop forgings produced net-shape or near net-shape (with minimal or no cutting operations).

Precision die forging can be used in dies with standard flash as well as in dies for flashless forging with open die cavity. However, application of precision die forging in forging with closed dies in warm provides the best conditions for achievement high precision of drop forgings and high efficiency of forged material. Exact volume of billet and suitable compensation method is needed to provide at the precision die forging in closed dies [1, 2, 3].

2. PARAMETERS OF PRECISION DIE FORGING

There are many technological and other process parameters which have influence on precision of drop forgings (Fig. 1). Technological parameters have important position in the design of manufacturing of drop forgings by precision die forging. Therefore, the design of suitable shape of billet is the object of our research. Design of the forging tool is the next evaluated technological parameter. This parameter closely connected with the designed shape of the billet. Proper design of compensation method of a little surplus of forged material is very important in the designing of closed die, too.

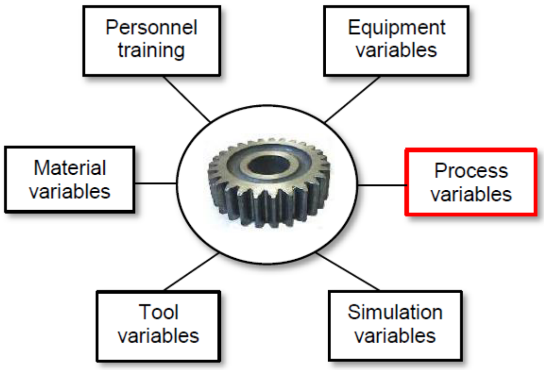

Fig. 1. Variables which have influence on precision of drop forgings [4]

High precision and surface quality of drop forgings at the suitable loading of forging die can be achieved by the reduction of forging temperature in the area of warm forging. The using of warm forging processes is very interesting for all manufacturers of precise drop forgings. The temperature range of steel warm forging processes is approximately 600 – 800 °C [5]. Forging temperature 700 °C has been chosen within this paper.

Suitable simulation software enables to search the influence of the technological parameters by their various combination. Numerical simulation is convenient tool for the technologist in production because the optimal conditions of forging process can be obtained quiet fast.

3. DESIGN OF A BILLET AND THE FORGING TOOL

Research on the optimalization of the technological parameters (dimensions of billet, tool design) of precision die forging in closed dies has been applied on spur gears with straight teeth with a hub. Shape of die cavity of forging tool and compensation method of surplus material relate with the design of billet shape. Shape of drop forging of the given spur gear is shown in Fig. 2.

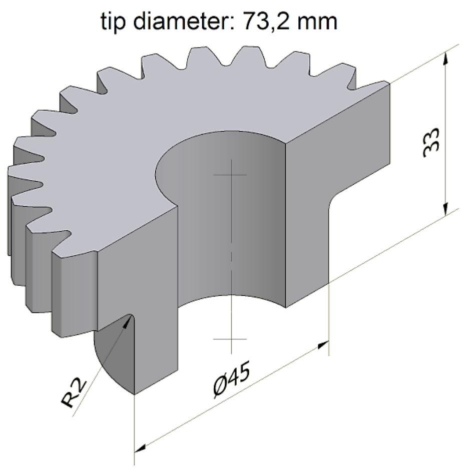

Fig. 2. Precision drop forging of spur gear

Case hardening steel STN 41 4220 has been chosen as a forged material. Chemical composition of this steel is shown in Table 1.

Table 1. Chemical composition of steel 14 220

	Chemical composition [% of weight]					
	C	Mn	Si	Cr	P	S
max	0,19	1,4	0,37	1,1	0,035	0,035
min	0,14	1,1	0,17	0,8		

The drop forging will be manufactured without the creation of a web. Therefore, ring billet has been designed. Two basic alternatives of the ring billet dimensions suitable for precision die forging are illustrated in Fig. 3.

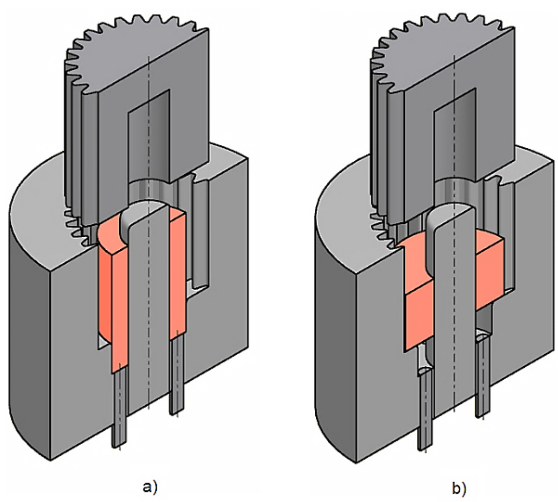

Fig. 3. Design of the forging tool with possible alternatives of billet dimensions 3a), 3b)

The following compensation method has been designed for both variants of billet dimensions (shown in Fig. 3):

- axial compensator placed between lower and upper die, illustrated in detail 1 in Fig. 4, is suitable for the alternative in Fig. 3a),
- container compensator placed bellow a hub of drop forging, illustrated in detail 2 in Fig. 4, is suitable for the alternative in Fig. 3b).

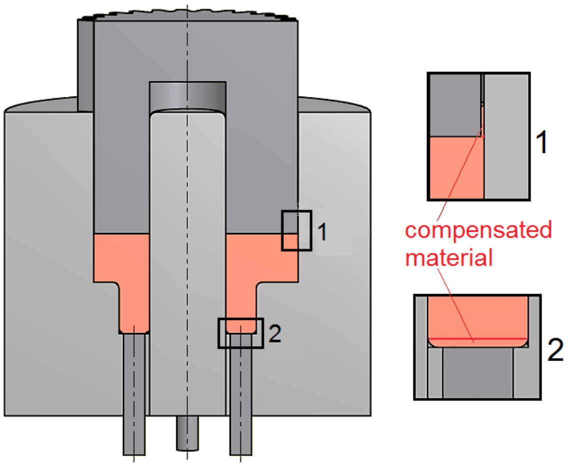

Fig. 4. Method of material surplus compensation

4. OPTIMALIZATION OF THE PARAMETERS WITH THE USE OF SIMULATION

Computer simulation is useful solution for prediction of the course of process and material behavior in die cavity. In this way, it is possible to optimize the tool shape and design technological process and by that considerably reduce financial costs of preproduction stages and production itself.

Optimalization of ring billet dimensions has been realized with the help of simulation program Simufact.forming. Suitability of the billet shape and dimensions has been evaluated primarily from the aspects of material flow in die cavity.

Simufact.forming program is suitable for the simulation of bulk forming processes in hot, warm or cold [6].

For starting the simulation in the preprocessing stage it is necessary to define the input data properly:

- process – closed die forging in warm,
- material of a billet – DIN 17210 (1.7131),
- material of the tool – ASTM A 681 (H13),
- temperature of a billet – 700 °C,
- temperature of the tool – 250 °C.

The picture illustrated in Fig. 5 shows that the material flow in die cavity of closed die by the forging with ring billet placed in the bottom of a hub is wrong because of the relation of the lead. It is possibly to state that the designed dimensions of billet in Fig. 3a) are incorrect and they do not guarantee faultless manufacturing of the given drop forging by warm forging.

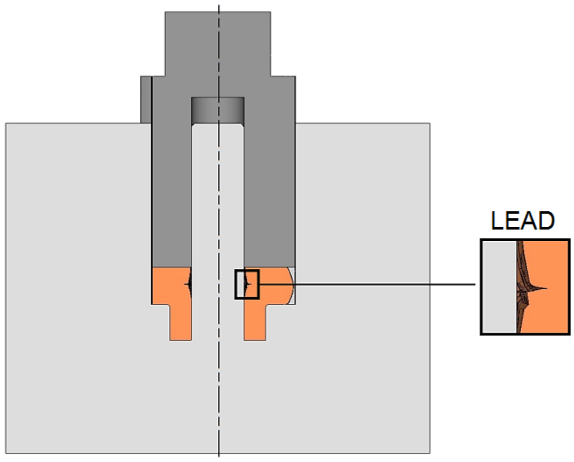

Fig. 5. Incorrect material flow in die cavity

Computer simulation of material flow in die cavity where the ring billet is placed on the bottom surface of a ring with toothing is shown in Fig. 6.

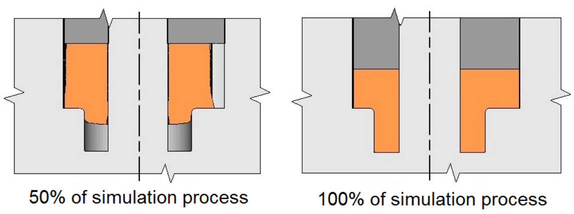

Fig. 6. Suitable material flow in die cavity

Suitable material flow in die cavity in the temperature of warm forging for the dimensions of ring billet shown in Fig. 3b) has been evaluated with the help of computer simulation. Both the progress of effective plastic strain and temperature areas of drop forging, where the ring billet fits on the bottom surface of a ring with toothing have been evaluated. The results of computer simulation are shown in Fig. 7 – Fig. 10.

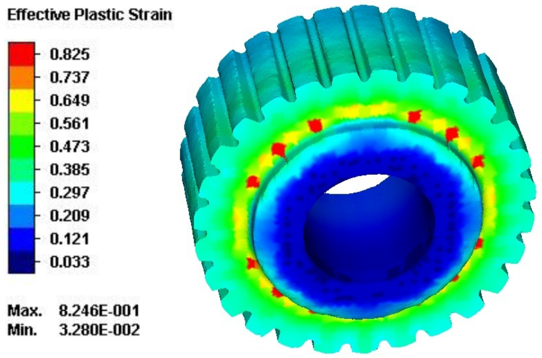

Fig. 7. Effective plastic strain at the 50 % of simulation process

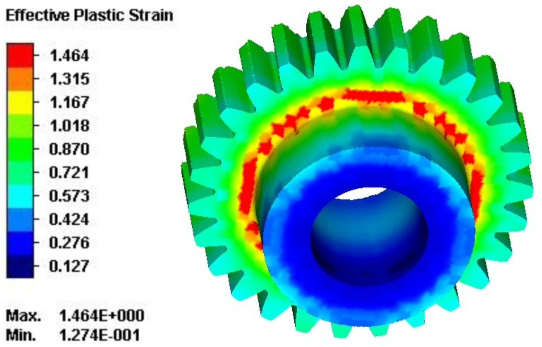

Fig. 8. Effective plastic strain at the 100 % of simulation process

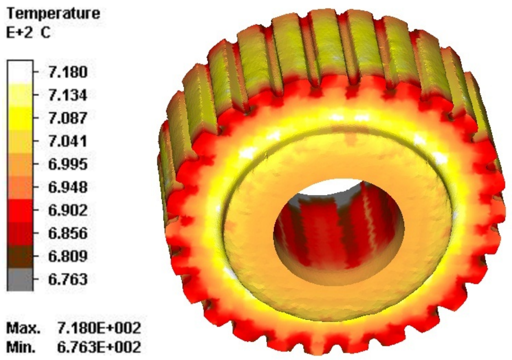

Fig. 9. Temperature fields at the 50 % of simulation process

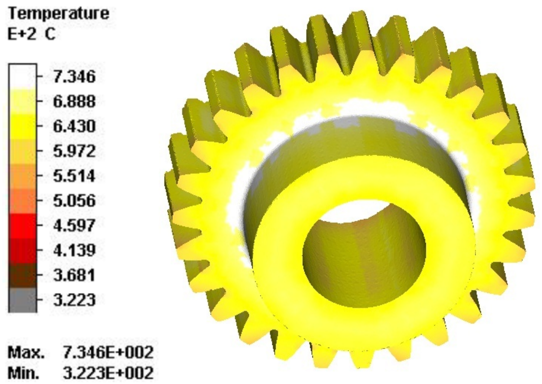

Fig. 10. Temperature fields at the 100 % of simulation process

The computer simulation proves that the highest values of the effective plastic strain and temperature have been observed in the area of the fillets from the ring to the hub.

5. CONCLUSION

The choice of billet dimensions and design of the forging tool is very important for the design of the technological parameters of precision die forging. Two basic alternatives of ring billet dimensions and the shape of die cavity for the manufacturing of given drop forging of spur gear have been designed. Incorrect material flow in die cavity where ring billet fit on the bottom of a hub has been detected with the help of computer simulation. The lead has been created near the forging spike in the area of ring with toothing. Optimal material flow in die cavity can reached in precision die forging in close dies in warm (700 °C) with the use of ring billet placed on the ring and container compensator placed bellow a hub. To meet all the requirements on precision of drop forgings in international competition it is necessary to take into consideration optimalization of technological parameters with the use of computer simulation.

6. ACKNOWLEDGEMENTS

This article has been created with the support of project VEGA 1/1041/11.

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The influence of cold rolling and artificial aging on the tensile behaviour of reinforcing bars

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Abstract

In this paper the influence of cold rolling and artificial aging on reinforcing bars is discussed. A hot rolled wire has undergone next process by cold rolling. The relative cross section change ranges from 17.4% to 47.1% after cold rolling. The wire of steel BSt 500 M was used as an experimental material. Thus deformed and hardened material underwent artificial aging and we examined the influence of aging on mechanical properties. The research of mechanical properties by using tensile tests was made on nine reinforcing bars of various diameters without artificial aging and on nine reinforcing bars after artificial aging. All tested reinforcing bars have complied with valid standards. The artificial aging process did not cause a significant change of yield strength and tensile strength but caused the decrease in elongation to failure average of 15%. From the point of view of fracture evaluation, we can state that the fracture is a shear fracture after the tensile test.

Keywords: Reinforcing bars; Cold rolling; Tensile test; Artificial aging of steels.

1. INTRODUCTION

The emergence of new anti – aging steels in recent time has caused that a little attention has been dedicated to aging on steel properties, but the study of this is still important and topical [1]. Moreover due to corrosion, steel properties can drop to values lying below the limits for the using reinforced concrete members. [2]

To produce reinforcing bars, a hot rolled wire rod is cold rolled into a ribbed wire rod. The wire contains oxides on the surface which must be removed before cold rolling [3]. The usage of reinforcing bars requires certain minimum mechanical properties after cold rolling i.e. the minimum yield strength $S_{0.2}$ = 500 MPa, the minimum tensile strength S_u = 550 MPa and the minimum elongation to failure A_{10} = 8%.

The term aging is used to characterize time dependent strengthening processes which occur in plastically deformed metals and alloys [4]. Aging process in reinforcing bars develops after acquiring energy (a heat or a mechanical energy) and the supersaturated solution of interstitially dissolved elements starts to decompose. [5]

The aim is to find the influence of cold rolling and verify if at least minimum required values are present in reinforcing bars despite the aging effect. Especially, the yield strength is important, because at the design of reinforced structures, the stress is calculated by using the yield strength [6]. Furthermore, we were interested in the fracture type of reinforcing bars after the tensile failure. We know four fracture types: punctual, shear, cavitation and brittle [7].

2. METHODS AND MATERIALS USED FOR RESEARCH

The research was conducted for reinforcing bars made of hot rolled wire of deoxidized steel BSt 500M with guaranteed weldability of DIN 488 part 1. [10] The chemical composition of steel BSt 500 M is displayed below in Table 1. As reinforcing bars as hot rolled wire requires certain minimum mechanical properties after hot rolling for production of reinforcing bars i.e. the minimum yield strength $S_{0.2}$ = 235 MPa, the minimum tensile strength S_u = 360 MPa and the minimum elongation to failure A_5 = 26%.

Mechanical properties of hot rolled wire of the steel BSt 500 M were provided by its producer. We could not compare elongations to failure before (A_5) and after (A_{10}) cold rolling because of different values of initial measured lengths (for the evaluation of elongations to failure).

Table 1. Chemical composition of steel BSt 500 M [10]

Element	C	P	S
weight %	max. 0.22	max. 0.05	max. 0.05

To verify the mechanical properties of reinforcing bars influenced by aging we need not to wait for many years until the reinforcing bars will be naturally aged. It suffices when reinforcing bars undergo artificial aging. Results are similar to those of natural aging and foremost artificial aging takes less time. Artificial aging was executed on nine reinforcing bars at a temperature of 100°C for one hour. After the fall of temperature, the tensile tests were executed.

By reason of comparison, nine specimens of reinforcing bars were tested without the influence of aging immediately after cold rolling. Tensile specimens of the steel BSt 500 M of 400 mm length and various diameters were used. The measured length was $10.d_1$. We acquired the tensile properties by using the tensile test as the yield strength $S_{0.2}$, the tensile strength S_u and the elongation to failure A_{10}.

Tensile test at ambient temperature was executed on an electro mechanic tensile machine in accordance with standard. [9] Reinforcing bar after a failure is shown in Fig. 1. Strength values were calculated from special tables with the cross sectional area according to: [8].

There are values α, β, γ in Table 2. Value α is a yield strength ratio of reinforcing bars without and after artificial aging. The value α in % is calculated according to formula:

$$\alpha = \frac{S_{0.2}'' - S_{0.2}'}{S_{0.2}'} .100 \tag{1}$$

where $S_{0.2}'$ is the yield strength of reinforcing bar without artificial aging in MPa and $S_{0.2}''$ is the yield strength of reinforcing bar after artificial aging in MPa.

The value β in % is the tensile strength ratio of reinforcing bars without and after artificial aging and it is calculated as:

$$\beta = \frac{S_u'' - S_u'}{S_u'} .100 \tag{2}$$

where S_u' is the tensile strength of reinforcing bar without artificial aging in MPa and S_u'' is the tensile strength of reinforcing bar after artificial aging in MPa.

The value γ denotes the tensile strength ratio of reinforcing bars without and after artificial aging. The value γ in % has been calculated by using the subsequent formula:

$$\gamma = \frac{A_{10}' - A_{10}''}{A_{10}'} .100 \tag{3}$$

where A_{10}' is the elongation to failure of reinforcing bar without artificial aging in % and A_{10}'' is the elongation to failure of reinforcing bar after artificial aging in %.

The relative cross section change after cold rolling denoted by ε_A in % can be calculated as:

$$\varepsilon_A = \frac{d_0^2 - d_1^2}{d_0^2} .100 \tag{4}$$

where d_0 is the reinforcing bar diameter without artificial aging measured in mm and d_1 is the reinforcing bar diameter after artificial aging in mm according to standard [8].

A fracture analysis – fractography was executed on a macro scale method utilizing a visual check. Fractographic examination was carried out on all tested specimens

3. RESULTS AND ACHIEVEMENTS

In light of the fracture evaluation of reinforcing bars, both types of specimens without and after artificial aging have exhibited a shear fracture (see in Fig. 1). The shear fracture, typical for ductile metals, only arises when conditions for a cavitation failure do not arise before the shear fracture in the middle of cross section or the direction of metal texture after cold rolling is identical to the direction of maximum shearing stresses [7]. In this case the shear fracture arose by the reason of that the conditions for the cavitation failure did not arise in the middle of cross section of tested specimens.

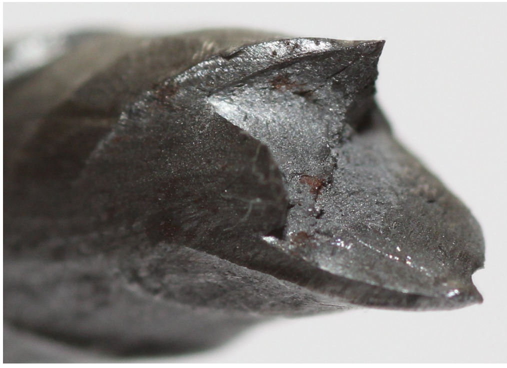

Fig. 1 The shear fracture of reinforcing bar

The cold rolling process causes a mechanical hardening of the material. Thanks to cold rolling the yield strength and tensile strength of reinforcing bars increase compared to those of original hot rolled wire. The increase of yield strength and tensile strength depends on the relative cross section change. We can say, of the comparison of mechanical properties of hot rolled wire and reinforcing bars without artificial aging, the yield strength has increased in the range from 63% (d_1 = 10) up to 182% (d_1=4 mm) compared to the values of hot rolled wire. The tensile strength has increased in the range from 42% (d_1=10) up to 77% (d_1=4 mm) compared to the values of hot rolled wire. The difference among tensile strengths before cold rolling and after cold rolling is shown in Fig. 2.

There is the comparison of mechanical properties of reinforcing bars without artificial aging and reinforcing bars after artificial aging in Table 2. Regarding mechanical properties of reinforcing bars after artificial aging, we can state the greatest change was at the elongation to failure. The average elongation to failure has decreased from 11.1% to 9.4% and the average loss reached 15%. On the other hand, the change of yield strength and tensile strength of reinforcing bars without and after artificial aging is insignificant. For comparison, the average increase of yield strength was 4.7% and the average increase of tensile strength was only 0.5%. A difference between tensile strength without artificial aging and after artificial aging is shown in Fig. 2.

Table 2. The influence of cold rolling and artificial aging on the change of mechanical properties

Wire diameter		Relative cross section change	Mechanical properties of hot rolled wire			Mechanical properties of reinforcing bars after cold rolling and without artificial aging			Mechanical properties of reinforcing bars after artificial aging			Change of mechanical properties of reinforcing bars		
Before cold rolling	After cold rolling													
d_0	d_1	ε_A	$S_{0.2}$	S_u	A_5	$S_{0.2}'$	S_u'	A_{10}'	$S_{0.2}''$	S_u''	A_{10}''	α	β	γ
mm	mm	%	MPa	MPa	%	MPa	MPa	%	*MPa*	*MPa*	*%*	*%*	*%*	*%*
5.5	4	47.1	248	432	41.0	699	764	10.5	722	771	8.1	3.3	0.9	22.9
6	5	30.5	300	430	38.8	589	641	9.1	616	646	8.6	4.6	0.8	5.5
6	5	30.5	300	430	38.8	658	734	8.4	697	742	8.0	5.9	1.1	4.8
7	6	26.5	305	431	38.7	580	633	11.3	626	635	9.3	7.9	0.3	17.7
7	6	26.5	305	431	38.7	615	650	10.9	617	650	8.0	0.3	0	26.6
7	6	26.5	305	431	38.7	579	634	12.8	596	632	12.0	2.9	-0.3	6.3
9	8	21.0	262	433	39.2	551	615	11.8	590	617	9.8	7.1	0.3	17.0
9	8	21.0	262	433	39.2	577	656	11.5	614	660	9.5	6.4	0.6	17.4
11	10	17.4	309	430	33.5	504	611	13.3	522	615	11.0	3.6	0.7	17.3

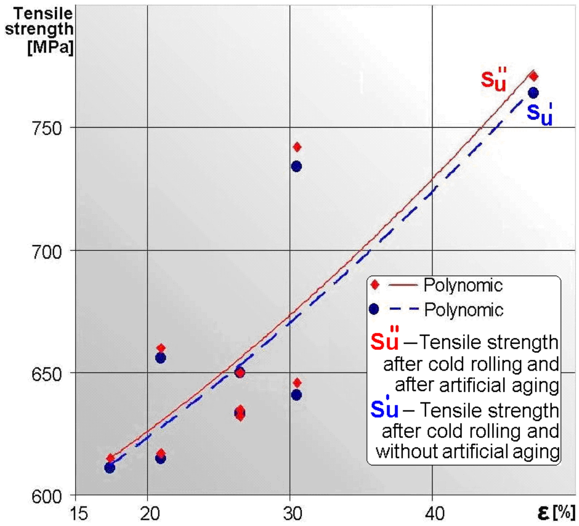

Fig. 2. The influence of relative cross section area on mechanical hardening of steel BSt 500 M after cold rolling

4. CONCLUSIONS

This paper deals with the research of mechanical properties of reinforcing bars and it has given a number of findings. Due to cold rolling, the values of yield strength and tensile strength markedly increase, thanks to that, the yield strength and tensile strength meet required criteria according to standard. The increase of yield strength and tensile strength depends on a relative cross section change by cold rolling.

The research of mechanical properties of reinforcing bars has shown that the yield strength, tensile strength and elongation to failure have not changed in a significant way after artificial aging. Both kinds of values, the yield strength and tensile strength meet required criteria at all tested specimens. The elongation to failure of reinforcing bars decreased after artificial aging yet despite that the elongation to failure complied with a threshold value of 8%. The fracture analysis found that the specimens had torn by a shear fracture in the root of the localized neck.

In fine, we can state that the effect of artificial aging influences the mechanical properties of reinforcing bars, but not in the way that it may have a negative influence on the usage of reinforcing bars. The steel BSt 500 M ranks among deoxidized steels, which are not so susceptible to aging and it could be the reason of small change of mechanical properties.

5. ACKNOWLEDGEMENTS

We gratefully thank the company RIM-PONA SLOVENSKO, spol. s r. o. for helping us to provide specimens for the research.

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Application of polymer materials for reducer

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Abstract

Reducers are a crucial element of most machines nowadays, either in terms of reducing speed or increasing torque, used to transmit torque from the driving shaft on the driven device. Depending on the machine or application, the factors that influence on optimal selection of right reducer is the gear or gear type, gear ratio, torque, size, service factor and the load. Reducer are usually made from metallic materials, but this paper deals with parts made of polymer materials that has the possibility to regulate speed and torque to the output shaft.

Keywords: Reducer; Polyamide cone frictional wheel; Pulley; Sliding bearing; Polyester resin.

1. INTRODUCTION

There are reduction gearboxes that transmit torque by means of forms (gears) and friction (friction transmission). Friction transmissions are divided into: a) transmissions with constant transmission ratio, b) transmissions with variable transmission ratio, c) transmissions for changing the direction of rotation of the driven shaft, and d) transmissions that convert rotation into translation movement. [1] Examples of friction transmissions are presented in Figure 1.

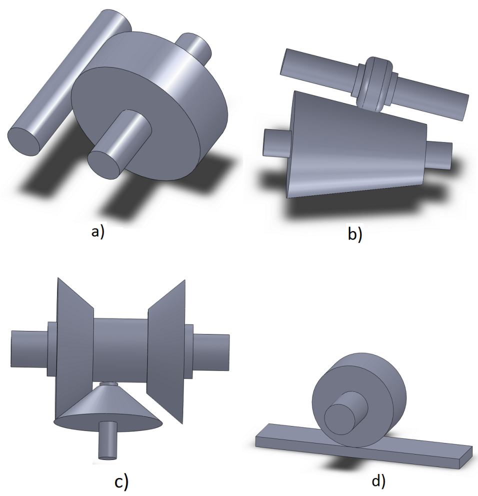

Fig. 1. Division of friction transmissions [1]

In transmission of movement by means of friction there is the possibility of slippage which is not desirable except when it refers to protection against overload. In order to avoid slippage a condition has to be fulfilled that the peripheral force of the friction gear is lower than or equal to the friction force that depends on the contact pressure and on the factor of friction between the friction gears. The advantages of the friction transmission include simple design, quiet operation, the movement is transferred elastically and there is no fracture of the transmission elements even in case of overload. [2, 3]

The restriction of the friction transmission is low torque that can be transmitted. If transmission with higher moments is required, the force between friction surfaces has to be increased, thus significantly increasing the forces in the bearings. By increasing the peripheral speed the slippage is increased, and thus the energy losses as well. Many types of transmissions with variable transmission ratio have been developed, and all are characterised by simple design. They are applied in different fine-mechanical devices. [4] Figure 2 shows some of the designs of transmissions with variable transmission ratio: a) with cone friction pulley, b) with plate friction pulley, c) with ball friction pulley, and d) with globoid friction pulley.

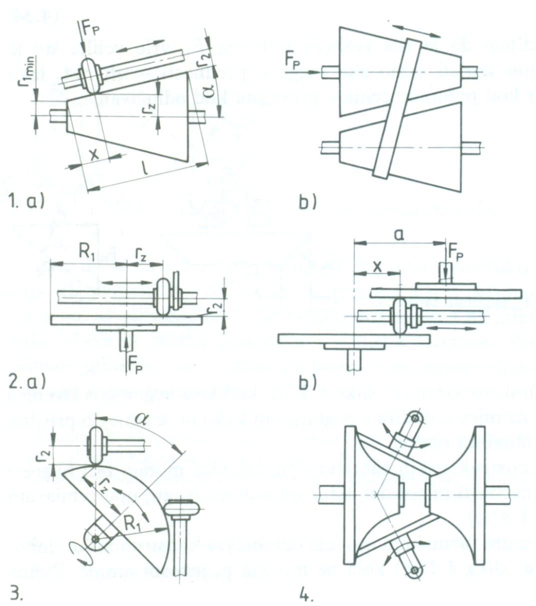

Fig. 2. Transmissions with variable transmission ratio[5]

The developed reducer uses two cone friction pulley and an elastomeric mobile friction pulley.

2. MATERIALS USED FOR REDUCER DESIGN

In the work a reducer has been designed with parts made of polymer materials. The reducer has been designed with cone friction pulley in order to regulate the output speed, and the final transmission has been provided by belt transmission. The basic used thermoplastic material in producing the reducer is polyamide (PA). The parts made of polyamide have been produced out of semi-products by means of machining. The reducer housing was made of composite material by manual glass fibre lamination procedure, and polyester (UP) and epoxy resin (EP) was used as matrix. The housing cover was made of semi-product of poly(methyl-metacrylate) (PMMA) since it is transparent and makes it possible to see all the parts. Out of elastomeric materials the reducer contains a seal made of elastomeric polyurethane and a moving friction pulley which was made on the basis of natural rubber. Apart from prevalently used polymeric materials, metal parts have also been used in the reducer (bolts, nuts, washers, winding rod and elastic ring as well as the support of the moving friction pulley made of stainless steel).

2.1. Application of polymeric materials for the production of reducers

The basic used thermoplastic material was PA, of 100 mm useful diameter, defining with this diameter the dimension of the pulley and the bigger friction pulley. In the smaller friction pulley the bigger diameter was equal to the smaller diameter of the bigger friction pulley. The smaller friction pulley was designed with equal bevel as the bigger one and they were connected with the moving friction pilley which was made of natural rubber. The moving friction pulley is in contact with the cone friction pulley by means of a metal structure with springs, which are used to regulate the pressure force and thus also the torque which can be transferred. The smaller friction pulley is directly connected to the electrical motor, and the bigger one over the v-belt to the pulley. The pulley is at the same time the output shaft. From the bigger friction pulley to the pulley the speed is reduced 2.5 times. By means of variable friction transmission it is possible to regulate the transmission ratio between 1 and 4, so that the highest transmission ratio amounts to 10, and the lowest 2.5. For bearing of the friction pulley and the pulley the sliding bearings were used. Since the pulleys and the friction pulley are made of polymers, it would be best if the sliding bearings were made of metal of over 50 HRC hardness, but coupling with polymeric material is also favourable. In case of more severely loaded bearings and higher speeds couples of the same polymers should be avoided, since there is the possibility of sliding sticking. In case of the respective structure there was no such possibility and therefore the sliding bearings used were of the same material and made of PA. The advantages of using polymers for sliding bearings include the possibility of dry run, they are almost maintenance-free, resistant to corrosion, chemicals, and excellently dampen vibrations and impacts, there is mass saving, simple and inexpensive production. [6, 7]

The housing was made of glass fibres and polyester resin, and epoxy resin was used for the cover. The housing was made by manual lamination procedure where layer by layer of fibres and resin were applied to the model. Epoxy resin was used for the cover since it does not erode styrene, so that styrofoam could be used for the model. Additional advantages of epoxy resin include the fact that the product is of higher strength, and in crosslinking does not emit intense smell as polyester resin. Epoxy resin features much less viscosity than polyester resin and therefore polyester resin is better for the production of more complex forms such as the housing. The advantage of polyester resin is faster crosslinking which shortens the time between layer applications.

Adequate holes have been made in the housing and on the cover for the sliding bearings, switches, screws, supply and for the instrument. The sliding bearings have been made from semi-product by machining. Before installing the sliding bearings the sliding surfaces were polished in order to obtain minimal roughness, thus reducing the friction factor between the sliding pairs, which resulted in lower sliding wear and easier starting of the reduction gearbox. The sliding bearings, were set into the housing and the cover and were then embedded by epoxy resin, and where necessary, reinforced by glass fibres.

The next step in the production of the reducer was the production of the semi-round engine cover, which was made in the same way as the housing.

The upper cover was made of polymethyl-metacrylate (PMMA).

After having completed the housing, the following was produced: two cone friction pulley (Figures 3 and 4), pulley – Figure 5, spindle and support of the moving friction pulley. These parts were made from the semi-products by machining method. In case of friction pulley and pulley, due to the already mentioned reasons, the surfaces that are in contact with sliding bearings have been polished.

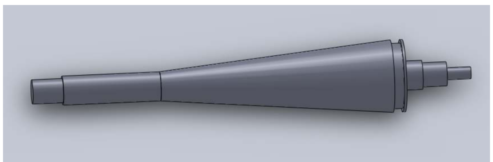

Fig. 3. Friction pulley 1

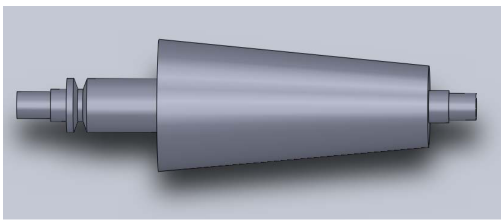

Fig. 4. Friction pulley 2

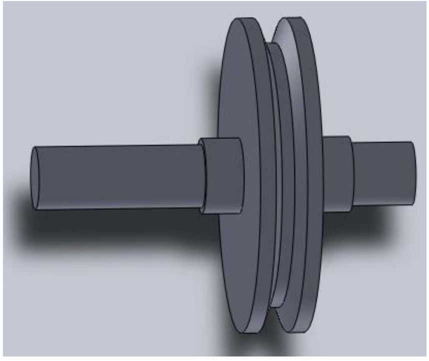

Fig. 5. Pulley

The mobile friction pulley was produced by direct pressing out of natural rubber and mounted on a metal structure presented in Figure 6.

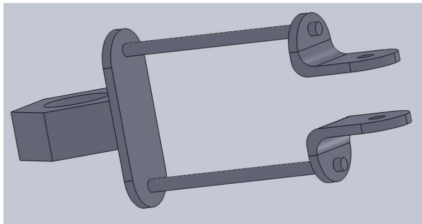

Fig. 6. Metal structure

Prior to the very assembling of the reducer all the sliding bearings were lubricated. According to the described procedure, a prototype of the reducer presented in Figure 7 was produced.

Fig. 7. Prototype of the reducer

3. CONCLUSIONS

By producing the prototype of the reducer out of polymeric materials it has been shown that the reducer, due to elastic deformation of the moving friction pulley, transmits higher torque than planned, but only in one direction of rotation. During production it was found that polymeric materials feature many advantages over other types of materials, which include: low density, no corrosion, they are less expensive, can be primary shaped and re-shaped, they dampen well the vibrations and they are good thermal and electrical insulators. By combining different polymers, the desired sliding properties can be achieved as required, in case of sliding bearings low friction factor and low energy losses have been achieved, and in mechanical torque converters (friction pulley and pulley) relatively high friction factor is achieved. The housing was made using simple tools, and extremely good mechanical properties have been obtained. Some of the favourable properties of polymers have been mentioned, which are the reason for the constantly increasing application of polymeric materials in the technology, the trend which is to continue in the future as well.

4. ACKNOWLEDGEMENTS

This work is part of the research included in the project *Increasing Efficiency in Polymeric Products and Processing Development*, which is part of program *Rapid Production — From Vision to Reality* supported by the Ministry of Science, Education and Sports of the Republic of Croatia. The authors would like to thank the Ministry for the financing of this project.

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CAE injection molding and structural analysis in metal to plastic conversion of bolted flange joint - case study

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Abstract

Many metal parts in various applications are being replaced by plastic parts. There are several reasons for that depending on actual application - minimize part cost, enhance corrosion resistance, integrating more components into one part etc. Most important steps of metal to plastic conversion are material selection and design of plastic part. Plastic part has to withstand the same load as metal part. To fulfill this requirement fiber reinforced engineering plastics are often used. Also it is convenient to substitute heavy wall sections with ribbed structure to increase load-carrying ability of part and decrease cycle time, eliminate voids, sink marks etc. Mechanical properties of such part could be highly affected by fiber orientation. Results of fiber orientation from injection molding filling analysis can be used in stress analysis for better prediction of part response to mechanical load. Such coupled analysis is performed here in this case study on bolted flange joint.

Key words: Injection molding simulation; CAE; Metal to plastic conversion; Fiber reinforced plastics.

1. INTRODUCTION

Many metal parts in various applications are being replaced by plastic parts. There are several reasons for that depending on actual application - minimize part cost, enhance corrosion resistance, integrating more components into one single part etc. Most important steps in metal to plastic conversion are material selection and plastic part design. Plastic part has to withstand the same load as metal part. To fulfill this requirement fiber reinforced engineering plastics are often used. Mechanical properties of fiber reinforced part are highly affected by fiber orientation as a result of flow. However fiber reinforced materials are often treated as isotropic materials what could lead to potential problems with final dimensions, warpage and/or poor mechanical properties in highly stressed areas of part. Assuming fiber reinforced plastic part as isotropic is convenient in preliminary design phase and preliminary stress analysis to find out where are the critical most demanding areas in terms of stress. These areas should be redesigned to meet the stress requirements, however a reduced stiffness and strength should be considered in this phase. Injection molding simulation follows after the preliminary stress analysis. For parts with heavy wall thickness and with thickness variations it is necessary to use 3D injection molding simulation to capture all phenomena related to fiber orientation. Important considerations in injection molding analysis are manufacturability of the part - the part should be void free, it should comply with warpage limits, dimensions etc. And the fiber orientation in the part should comply with mechanical loading of part to get the best possible mechanical properties for given applications. Fiber orientation is mostly affected by gate location and plastic part design. Final step in CAE approach is stress analysis with anisotropic material properties resulting from fiber orientation. Motivation for this case study was an existing design of injection molded flange made of PA66 GF30. It is DN80 flange, pressure class PN10. This design was converted from metal - ductile iron flange. Both designs are shown in *Fig. 1*.

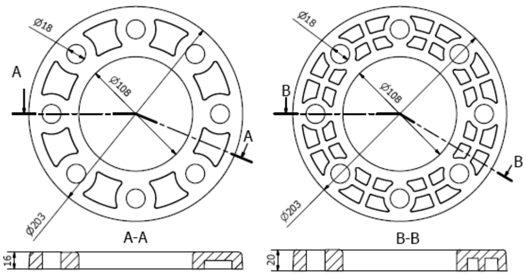

Fig. 1. Ductile iron and PA66 GF30 flange

Flanges from PA66 GF30 are injection molded with cold runner system with one gate.PA66 GF30 flanges failed to pass the load test. During the load test, two fittings were coupled with flanges and bolted together. After tightening the bolts to prescribed torque 40Nm, flanges cracked. Crack occurs mostly near the hole farthest from the gate. The location of the crack is in the thickest area of the part, wall thickness in this area is 17mm. Crack location and crack detail are shown in *Fig. 2*.

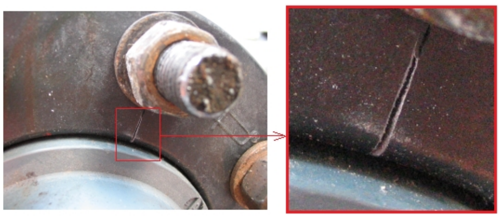

Fig. 2. Crack and crack detail

Voids and a foam like structure are visible on fracture surfaces (*Fig. 3*). This implies that the packing phase was not sufficient.

Fig. 3. Details of fracture surfaces

Injection molding analysis was performed on actual flange model with corresponding feed system and injection molding parameters. Material in thickest locations is still far above melting point, while the cold runner system is already frozen (*Fig. 4)*. Volumetric shrinkage can not be further compensated by adding new material, thus voids form in these locations. The largest void would be in the area with largest volumetric shrinkage, which is the thick section near the hole farthest from the gate as shown in *Fig. 5* - this is also the area where material started to crack during load test. However it is not only the void factor that contributed to the crack formation, but also the weld line in this location. Strength of PA66 GF30 decreases in weld lines about 15 to 17%. Weld line formation and resulting fiber orientation are shown in *Fig. 6* and *Fig. 7* respectively.

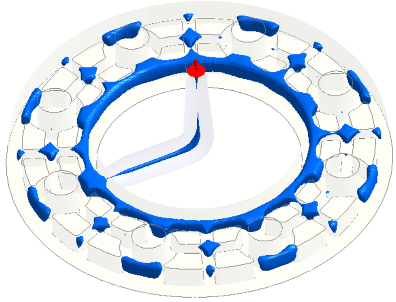

Fig. 4. Melting core after packing phase

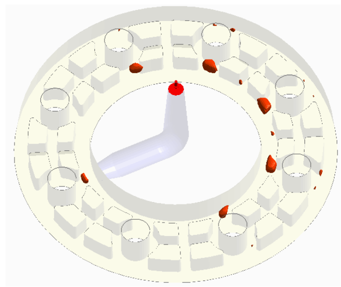

Fig. 5. Areas with highest volumetric shrinkage

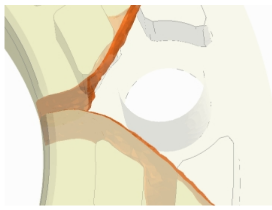

Fig. 6. Weld line formation

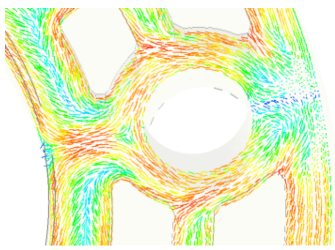

Fig. 7. Weld line fiber orientation

2. DESIGN, MATERIALS AND ANALYSIS APPROACH

The goal in this case study is to redesign the flange so it will meet the structural requirements (proposed design must withstand the load test) and also manufacturability requirements - proposed design must be void free after injection molding. Following CAE approach is used in this case study:

- redesign the flange,
- preliminary stress analysis of new design, design corrections, material considerations,
- injection molding analysis,
- stress analysis with consideration of fiber orientation.

New proposed design of flange is shown in *Fig. 8.* Thick sections were cored out and more stiffening ribs were added to support the structure. Preliminary stress analysis setup is shown in *Fig.9.* Clamping force 8,3kN was applied to each bolt, which corresponds to the tightening torque of 40Nm.

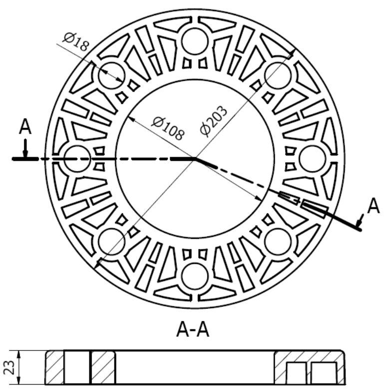

Fig. 8. Flange redesign

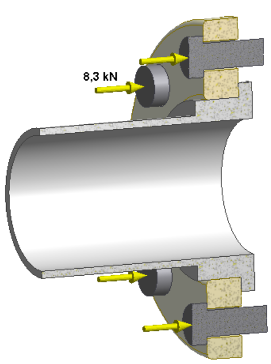

Fig. 9. Setup for preliminary stress analysis

3. RESULTS

Preliminary stress analysis was first performed with PA66 GF30, however stress levels were high for this material, so PA66 GF50 was selected instead. Reduced mechanical properties were assumed according to *Tab.1.* Since PA66 GF50 has a brittle behavior when loading at room temperatures a maximum normal stress theory can be assumed as a failure theory - however only in a "isotropic" analysis. Maximum principal stress in preliminary stress analysis reached **190MPa** as shown in *Fig. 10.*, and it is in the locations where flange "bends" over fitting. Maximum deflection in z direction was 0.5mm. These results seam to be good enough to go into injection molding simulation.

Table 1. Mechanical properties of PA66 GF50

PA66 GF50	data sheet	reduced
Tensile Strength	245 MPa	208 MPa
Tensile Elongation	3.0 %	
Tensile Modulus	16000 MPa	13600 MPa
Flexural Strength	360 MPa	306 MPa
Flexural Modulus	15000 MPa	12750 MPa

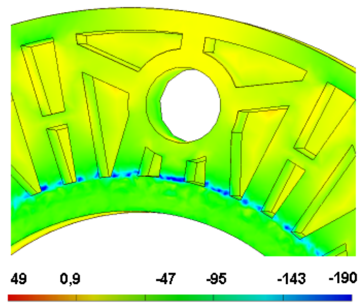

Fig. 10. Maximum principal stress

Injection molding analysis shown that new flange design can be molded without voids. Melting core at the and of packing is shown in *Fig. 11.* Highest volumetric shrinkage is 4.2% and its near the gate. Fiber orientation is shown in *Fig. 12* and *Fig.13* shows resulting mechanical properties (major modulus) of flange based on fiber orientation. It is clear from this result that very low stiffness was achieved in stiffening ribs, only about 8000 MPa, a half of the data sheet modulus.

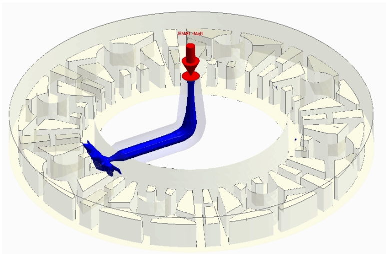

Fig. 11. Melting core at the end of packing

Fig. 12. Fiber orientation

Material properties resulting from injection molding analysis were mapped onto structural mesh from Ansys (solid186). Resulting mapped mesh is "assembled" from elements with different material properties - according to orientation of fibers. Static structural analysis was performed in Ansys with the same loads as in preliminary "isotropic" analysis. Third principal stress result plot is shown in *Fig. 14*.

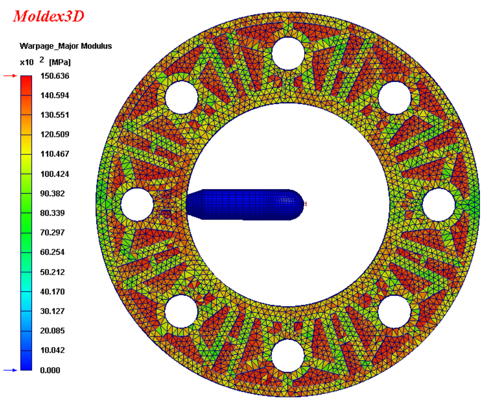

Fig. 13. Major modulus

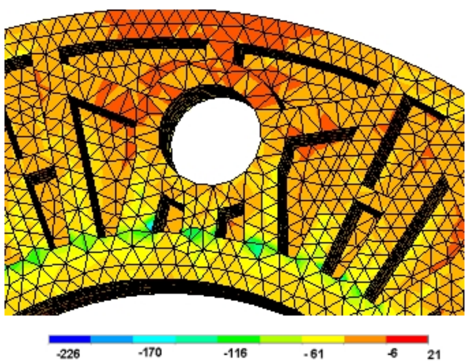

Fig. 14. Third principal stress result plot

Results from "isotropic" and anisotropic stress analysis are compared in *Tab.2*. Further research is needed for clear statement on failure of this part. Also the part design and gating options have to be reviewed, since the highly stressed locations have poor fiber orientation in relation to loading of this part.

Table 2. Summary of results from stress analysis

Stress [MPa]	isotropic	anisotropic analysis
1st principal	-97/102	-53/122
3rd principal	49/-190	21/-226
Von Mises	130	210
displacement z [mm]	-0.5	-0.65

4. CONCLUSION

In this contribution CAE approach for designing a reinforced plastic part was presented. Mechanical properties of fiber reinforced parts are strongly influenced by fiber orientation resulting from injection molding process. Orientation is mainly affected by gating of the part and part design itself. "Isotropic" approach is not sufficient for predicting part behavior under load. It can be convenient in preliminary design to find out stress requirements a then redesign the part accordingly or select different material. Injection molding simulation is vital to avoid defects in molded part such as voids. And in case of fiber reinforced materials to analyze the resulting fiber orientation and get anisotropic material properties. Anisotropic material properties from injection molding simulation can be mapped onto structural mesh and then stress analysis of molded part can be performed. Anisotropic stress analysis gives better insight on how the part will perform under load, what deflections can be expected. However, since there is different orientation, it is difficult to tell what are the allowable stress levels and thus whether the part will fail or not.

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Analysis of properties of an unconventional slip material made by an isostatic pressing of powder high-speed steel out of molybdenum sulphide

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Abstract

The aim of this study was to analyze tribological properties of new designed sliding material, which was manufactured by isostatic pressing of powder HSS grade STN 41 9830 with the various addition of MoS_2 in amounts of 2, 2.5 and 3 wt. %. The investigated properties of these prepared materials were compared with bronze reference standard of following chemical composition: Cu84-Ni5-Al9-Fe1-Mn1. The experimental results suggest that analyzed powder HSS materials with addition of MoS_2 exhibits very good sliding properties at severe operating conditions and they are suitable as sliding materials.

Keywords: Slip material; Wear; Powder metallurgy; High speed steel; Molybdén sulphide MoS_2.

1. INTRODUCTION

Many homogeneous materials can not fulfill the complex requirements for friction material and that is why composites are used. One of the progressive technology of producing these materials is sintering of powder materials using isostatic pressing.

Suitable choice of materials and appropriate combination of sintering process parameters (pressure, temperature, time of atmosphere) enable to prepare materials with better properties like conventionally produced materials. Such material is unconventional friction material based on high speed steel (HSS) with addition of molybdenum disulfide MoS_2.

It was established , that addition of MoS_2 increases the compressibility and further densification of HSS powders during uniaxial cold pressing [1,2].

The addition of MoS_2 into sintered HSS improved machinability and tribological properties, because of dispersed MoS_2 soft particles in hard and tough steel matrix [1,2], while the mechanical properties (hardness, strength) remained the same [3].

The studies are also oriented on the development of new composite materials with soft and hard phase, to adjust the tribological properties of composite materials [4]. The aim is to improve the machinability (valve seats) and self-lubrication (bearings and parts exposed to corrosion, vibration, etc.) [5].

The influence of varying amounts of MoS_2 addition into HSS on friction coefficient, temperature of the sliding pair and wear is described and discussed in this paper.

2. EXPERIMENT

Studied friction material was prepared by hot isostatic pressing of STN 41 9830

- high speed steel powder (HSS), with grain size - 40 to 160 μm

- MoS_2 powder with grain size - 10 μm

HSS powder was atomized by nitrogen with pressure from 1.4 to 1.6 MPa. Thus the O_2

content in HSS powder, does not increase above 0.02%, which corresponds to requirements necessary for isostatic pressing. The chemical composition of HSS powder determined in authorized institution Matec s.r.o Dubnica nad Váhom is in the table. 1.

Table 1. Chemical composition of STN 41 9830 HSS

Component	C	Mo	W	Cr	V
WT. %	0.85	5,20	6,57	4,1	1,77
Component	Mn	Si	S	P	O_2
WT. %	0,45	0,08	0,016	0,0022	0,0175

The addition of 2, 2.5 and 3 WT. % of MoS_2 powder into HSS was used powder. They were isostatically pressed at temperature of 1150 °C and pressure of 110 MPa during 90 min. Some samples were heat treated (austenitizing, quenching, tempering).

Friction properties of samples were tested by the test of ultimate load (the socalled short term test) of seizing test process on Tribotestor A 30.

Tribotestor A 30 is designed for rapid tests of parameters and characteristics of slide bearings. This device allows the simulation of operating conditions of sliding bearings in its test range.

The results of friction properties of tested friction materials were compared with bronze standard (chemical composition: Cu84 - Ni5 - AL9 - Fe1 - Mn1).

The tests of friction properties of HSS friction materials, with different contents of MoS_2 (2 %, 2.5 %, 3 %) can be evaluated like a short term (200 min.). Their aim was to find out the dependence of the friction coefficient μ and the temperature t of sliding pair (contact area) on loading F increasing at constant of sliding speeds v = 0.5 and 1 m/s. Lubrication of sliding pair was provided by dripping of the MADIT OL-B4 oil in periodic intervals, one drop of oil every 20 s. Before the start of each measurement the sliding pair was run-in first with constant load F = 200 N for 30 min. After this the loading force increased by 200 N every 10 min until 3600 N, which corresponds to the time of the test 200 min. Values of friction coefficient and temperature of sliding pair, depending on the time have been determined as arithmetic average of three measurements for each constant value of sliding speeds 0.5 and 1 m/s.

The obtained results of friction coefficient and temperatures of friction pairs characterize tribological properties of test samples.

3. RESULTS AND DISCUSSION

At the beginning of the tests, all samples has temperature 21 °C. During tests with speed speed v = 0.5 m/s lower values of friction coefficient and lower increase of the temperature of friction pair of samples with HSS + MoS_2 were measured compared to bronze standard, which can be seen on graphs on Fig. 1 and 2.

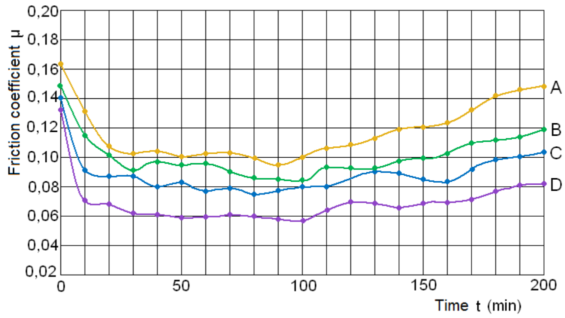

Fig. 1. Dependence of friction coefficient μ on t at v = 0.5 m/s. Curve A - Bronze standard (Ni Al Fe Mn) B curve - HSS + 2.0% MoS_2; curve C - HSS + 2.5% MoS_2; curve D - HSS + 3.0% MoS_2

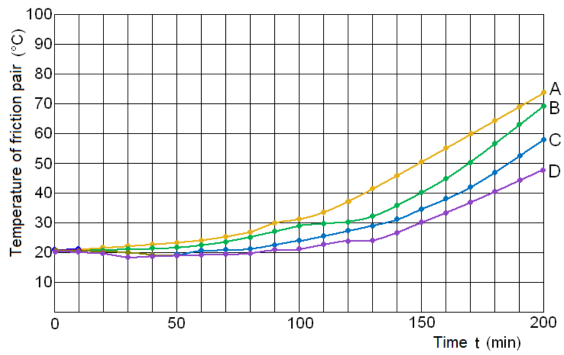

Fig. 2. Dependence of sliding pair temperature on time t at v = 0.5 m / s. Curve A - Bronze standard (Ni Al Fe Mn) B curve - HSS + 2.0% MoS_2; curve C - HSS + 2.5% MoS_2; curve D - HSS + 3.0% MoS_2

During beginning of friction pair for 30 min and 200 N load , a significant decrease in the friction coefficient for all samples by an average of μ = 0.06 was possible to see. This decrease was due to the progressive reduction of roughness of contact surfaces, due to their mutual contacts (running of sliding pair). During the run was not observed noticeable temperature changes. This may be attributed to reduction of the friction coefficient and so no significant amount of heat was generated by friction.

After 30 minutes of test, we can see for bronze standard (labelled A on Fig. 2) slight increasing of temperature and sample HSS + 3.0% MoS_2 (labelled D in Fig. 2) raising of temperature until after 100 minutes (which corresponds to the load 1600 N). This time difference of the beginning of temperature increasing is due to lower friction of samples HSS + 3.0% MoS_2 because of higher hardness of HSS and the presence of MoS_2 lubricant.

For bronze standard was observed the highest increase (from 30 min. to 200 min.) of friction coefficient, μ = 0.049 and for samples made from HSS + 3.0% MoS_2 was observed the lowest increase in the friction coefficient, μ = 0.024. For the sample HSS + 2.5% MoS_2 friction coefficient increased by μ = 0.026 and for the sample HSS + 2.0% MoS_2 friction coefficient increased by μ = 0.037.

Different increase of the friction coefficient of test samples is due to a variety MoS_2 content in the samples. By increasing the amount of MoS_2, friction coefficient decreases, because MoS_2 acts like a lubricant. Also increasing the amount of MoS_2 decreases the increase of temperature during the test, so the sample with 3.0% MoS_2 showed the lowest coefficient of friction throughout the test.

At sliding speed v = 1 m/s, could be again observed lower friction coefficient and lower temperature rise for the friction pair of HSS + MoS_2 could be observed again , than at bronze standard, which can be seen on the graphs on Fig. 3 and 4.

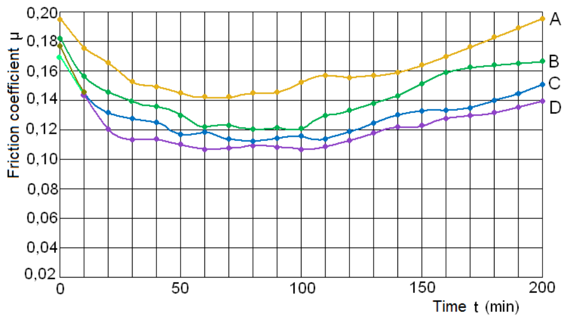

Fig. 3. The dependence of the friction coefficient μ on time t at v = 1.0 m/s. Curve A - Bronze standard (Ni, Al, Fe, Mn) B curve - HSS + 2.0% MoS_2; curve C - RO + 2. % MoS_2; curve D - HSS + 3.0% MoS_2

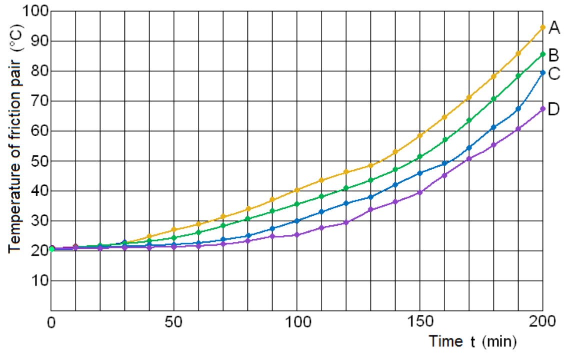

Fig. 4. The dependence of friction pair temperature on time t at v = 1.0 m/s. Curve A - Bronze standard (Ni, Al, Fe, Mn) B curve - HSS + 2.0% MoS_2; curve C - HSS + 2.5% MoS_2; curve D - HSS + 3.0% MoS_2

At this speed, the curves and the range of friction coefficient and temperature is very similar to the test with a sliding speed v = 0.5 m/s.

The comparison of measurement results, shows clearly that changes of the values of friction coefficient, using a sliding speed v = 1 m/s are significantly smaller than at test with a speed v = 0.5 m/s. Even at speed v = 1 m/s it can be seen, that with increasing quantity of MoS_2, friction coefficient decreases. Therefore, during all tests with both speeds, the sample HSS + 3.0 MoS_2, (labelled D on Fig. 1 and 3) showed the lowest friction coefficient.

When using the sliding speed v = 1 m/s, test samples reached following values of friction coefficient: a bronze standard μ = 0.195; HSS + 2 % MoS_2 μ = 0.165; HSS + 2.5 %, MoS_2 μ = 0.144 and, the sample HSS + 3 % MoS_2, reached the lowest value μ = 0.138.

The final values of temperature increases of samples tested at speed v = 1 m/s are: Bronze standard 74 °C; HSS + 2%, MoS_2 69 °C; HSS + 2.5%, MoS_2 58 °C and sample HSS + 3% MoS_2 reached the lowest value of 47 °C.

4. CONCLUSION

From the analysis of test results of tribological properties, the dependence of friction coefficient and abrasion temperature of friction pairs on test time can be seen, that all tested material prepared by isostatic pressing of the powdered HSS with different contents of MoS_2, exceeded the tribological properties of compared bronze standard.

With increasing MoS_2 content in HSS the friction coefficient and temperature rise of friction pairs decreases.

At test dependence the friction coefficient of the friction pairs from test time, lowest values of friction coefficient in given test conditions were observed at HSS 3% MoS_2.

At test dependence the temperature of friction pairs from test time lowest values of temperature rise were observed at HSS 3 % MoS_2.

The obtained research results can be used to introduce progressive technologies and materials to engineering practice, at production of nonconventional sliding materials with increased tribological parameters.

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EFFECT OF CLAMPING FORCE ON PARTS INACCURACY IN TURNING

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Abstract

Submitted article deals with a problematics of deviations origin in turning. Article is focus on dimension, shape and position deviations. Theoretical part of article is devoted to theory of inaccuracy in turning. Research of inaccuracy is performed with regard to the clamping forces. Clamping forces causes deviations of shape, position and dimension. Clamping forces are affected by pressure of clamping device and geometry of machined part and causes both plastic and elastic deformations of a part. What more, theoretical part of an article is devoted to theory of shape deviations focused on roundness deviation.Experiments were provided on DMG CTX Alpha 500 turning machine and as experimental parts were used bars with different lenghts and same diameters.Experimental section of the article brings roundness deviations measurement of inner diameter of machined part, when for each part, different set-out was used. The expectation is that higher set-out will cause higher deformations, consequently deviations of shape, dimension and position. For evaluation of experiments a athematical quantification of deviations is neccessary; for setting the right mathematical methods a theory of deviations origin is written in brief.Article brings an analysis of deviations origin in rotational parts machined by turning. Knowledge about deviations origin allows to eliminate it by professional customization of production which would provide more accurate production.

Keywords: Inaccuracy; Workpiece; Turning.

1. INTRODUCTION

Clamping forces deform the part. When the forces value is relatively low the deformation is elastic, however the higher value of clamping forces causes either plastic deformations. Both plastic and elastic deformation depend on part`s rigidity, which is provided by material characteristics of a part and its geometric parameters such as length, diameter, shape and thickness of walls. When a low level of rigidity is employed, high deformations are arising and vice versa; the higher level of rigidity, the smaller deformations. In turning the part is usually clamped into three bites chuck, which causes three clamping forces affecting the surface of a part. Because of low rigidity of a part, the part under the influence of clamping forces deforms itself, shown in Fig. 1. In turning e.g. inner surface, the machined cylindrical surface is produced on deformed surface of a part. This machined surface has required shape, accuracy and position in order of other surfaces only when the part is clamped in the chuck. It means that machined cylindrical surface will remain cylindrical even when clamping forces are at work. According to a state in turning mainly elastic deformations are arising, when clamping forces stops work i.e. the part is not clamped, elastic deformation will fade out and the part will retrieve its original shape without deformation. Therefore machined cylindrical surface produced under the influence of clamping forces deform itself. The principle is shown in Fig. 1, from left to right.

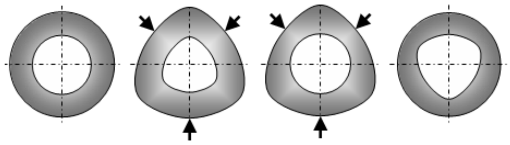

Fig. 1. Inaccuracies of a part, causes by clamping forces

When clamping forces value is high, yield strength is exceeded and the part deforms partially plastically. When clamping forces stops work, elastic deformation fade out, however the part will remain plastically deformed.

Inaccuracies caused by clamping forces can be eliminated by selection of suitable clamping device - clamping in collet or spike, when clamping forces are distributed to whole perimeter of a part and not affecting only three points like in three bites chuck.

2. EXPERIMENTAL

Submitted article is focused on experimental verification of clamping forces' influence on deviation of roundness. Experimental parts were clamped into three bites chuck with clamping force's value of 3.2 MPa and inner cylindrical surface was machined.

Cylindrical work pieces were made of a low carbon steel EN ISO C16E 1.1148 with diameter of ø 60 mm. Five parts were usedn in experiments with size (diameter x length) ø 58 x 30 mm.

Experiment was realized on DMG CTX Alpha 500 turning machine, used tool holder CNMG120404RP with blade A-DCLN-KC-95° (Kennametal).

Following cutting parameters and conditions were selected for experimental parts machining:

- feed f = 0,2 mm
- depth of cut ap = 1,5 mm
- cutting speed vc = 200 m/min

No cutting fluid was used when machining of experimental parts.

All experimental parts were clamped in the same distance from the chuck from outer surface with work piece set-out on the line (Fig.2) i.e. the line was at the edge of chuck's bites.

Then inner cylindrical surface was machined with depth of cut ap=1.5 mm into inner diameter of ø 33 mm.

In the next step, the face of a part was machined with cutting depth of ap = 0.2 mm in order to achieve the perpendicularity to part's longitudinal axis . This is necessary in order to ensure desired position of a part in measurement.

Measurement of roundness' deviations was realized on a ZVL MK 300C device for roundenss measurement. Measurement was realized as following (Fig. 2): roundness' deviation on part n.1 was measured in distance of 28 mm from the line (the same line of what the workpiee was clamped into the chuck). Part n.2 in distance 28 and 33 mm, part n.3 in distance 28 and 33 mm, part n.4 in distance 28,33 and 43 mm and part n.5 in distance 28,33,43 and 48 mm.

Measured values are showed in Tab.1.

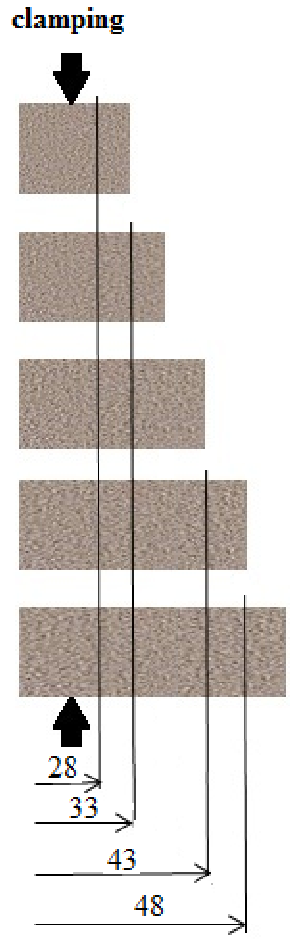

Fig. 2. Measurement principle

Table 1. Measured values in roundness deviation measurement

a	Part	Filter 2 - 500	Filter 2 - 15	Filter 16 - 150
28	1	10,8	3,6	6,8
	2	3,9	3,3	1,7
	3	9,7	5,1	3,1
	4	11,1	4,7	5,5
	5	4,2	2,5	1,3
	ϕ	7,94	3,84	3,68
33	1	x	x	x
	2	8,1	2,4	3,5
	3	4,4	2,8	1,9
	4	7,2	4	4,3
	5	3,3	1,6	1,1
	ϕ	5,75	2,7	2,7
43	1	x	x	x
	2	x	x	x
	3	x	x	x
	4	7,6	2,1	5,1
	5	6,5	1,8	4
	ϕ	7,05	1,95	4,55
48	1	x	x	x
	2	x	x	x
	3	x	x	x
	4	x	x	x
	5	5,5	1,3	1,7
	ϕ	5,5	1,3	1,7

Note: a – distance from chuck

3. RESULTS AND ACHIEVEMENTS

Fig. 3 shows graphical dependency of mean values of roundness on distance from clamping line. Values are slightly falling down in dependence on distance from clamping line is rising. More filters were used in measurement (2-500, 2-15, 16-150), however the dependence is the same for all of them. Roundness is approximately 2-3 times higher when a 2-500 filter was used compared to a 2-15 and 16-150 filters.

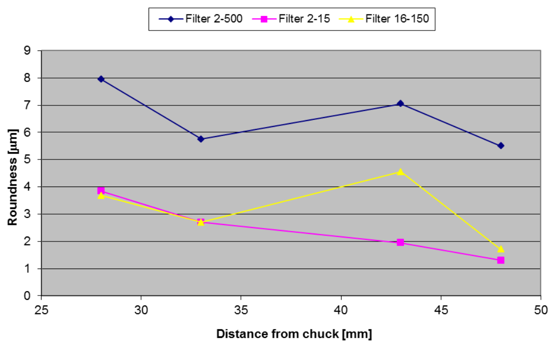

Fig. 3. Graphical dependency of mean values of roundness on distance from clamping line

4. CONCLUSIONS

Measured values earned by experiments and presented in submitted article shows there is a deformation of work piece in clamping in turning. The deformation has effect on geometric deviation of machined surface. According to a measurement it is possible to predict a fact, in clamping the deformation is rising which has negative effect on geometric accuracy of a part, consequently the deformation causes roundness failure. Roundness failure is highest at the points of clamping, and it is falling down along the axis with the distance from clamping points. It can be explained by a simple fact, that with raising distance from clamping points, the deformations are falling down since the force is not affecting whole part.

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Breach of surface layers in the abrasive wear surfacings

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Abstract

This article deals with the study of weld pool crystallization and composite distribution in the volume of weld bead and the surfaced piece as a whole in dependence on the selected parameters and surfacing technology. Main goal presents the evaluation and description of the composite surfacing invasion in the abrasive environment. The theoretical part includes the information collected from the literature resources concerning the crystallization resulting in the radical change of the material structure and properties. Crystallization process in the composite surfacing was observed during the laser surfacing and TIG (Tungsten inert gas) surfacing in the experimental programme. Moreover, this part also describes the laser surfacing technology in theory, TIG surfacing technology, surfacing tribology and the very process of crystallization. Distribution of the composite in the weld pool depends on the shape of the pool and the weight of the individual particles of the composite. The composite part sets in the process of segregation, or more precisely liquation, at the dendrites extension which is formed by bare metal with higher concentration of high-level fusible component and the low-level fusible components fill in the inter-dendrites spaces. On the ground of this assumption, the surfacing parameters and the form could be influenced by the surfacing mode, so it was possible to control the part of the composite trapped at the extension of the dendrites and in the inter-dendrites spaces. By this means, the resistance to the surfacing surface layers wear using the particles regulation in the tribology contact space was directly affected. The experimental part describes the procedure of samples surfacing using the laser beam and TIG surfacing with the use of the selected filler materials in the form of the filled tubular wire. Further, the macrostructure and microstructure of the surfacings, micro hardness and abrasive wear resistance test are documented. Finally, the results reached in individual tests are evaluated. In conclusion, the appropriate weld forms are recommended regarding the composite distribution in the surfacing and the best wear resistance.

Keywords: Abrasive wear; Surfacing; Tribology; Filler material.

1. INTRODUCTION

Metallic systems setting is characteristic for changes manifesting as formation of nuclei and their growth. Formation of crystal structure during the setting takes place in two phases:

a) Nucleation – the process, in which nuclei are formed in the initial phase (in melting), it means first volumes of solid phase. Nucleation is significant for the whole process of crystallization.

b) Nucleus growth is the second phase of state transformation. Nucleus growth is understood as gradual shift of the boundaries created during nucleation between the nucleus and melt. Transforming of a melt to solid phase does not take place in the whole substance at the same time. It begins in great number of places by creating of crystallizing nuclei – nucleation. Crystallizing nuclei may be formed by two means:

· **homogeneous** nucleation, in which nuclei are created directly from the melt, by concourse of atoms into the crystal grid – so called own nuclei.

Probability of nuclei creation is the same in all places within the melt.

· **heterogeneous** nucleation, in which own nuclei are not created, but there are crystallizing formations in the melt considered to be nuclei (carbides, oxides, nitrides, impurities etc.) [1].

2. METHODS AND MATERIALS USED FOR RESEARCH

It is assumed that composite distribution in the weld pool will depend on the shape of pool and weight of individual particles of composite. Therefore, the part of composite will set in the process of segregation, or more precisely liquation near the extension of dendrites that is formed by bare metal with higher concentration of high-level fusible component. At the same time, low-level fusible components fill in the interdendritic spaces, eventually eutecticum can be used there. Following this assumption, it is possible to influence the form and parameters of the surfacing by surfacing mode and so control the part of the composite that is caught on the extension of dendrites and in interdendritic spaces. Therefore, there were two welding technologies designed within the experimental part – laser and TIG process. These technologies have significantly different forms and parameters of the weld and, in the process of crystallization, different growth direction of crystallites from the weld pool. On the ground of these facts, it is possible to affect directly the resistance against the surfacing surface layers wear by regulating the amount of particles in tribology contact space.

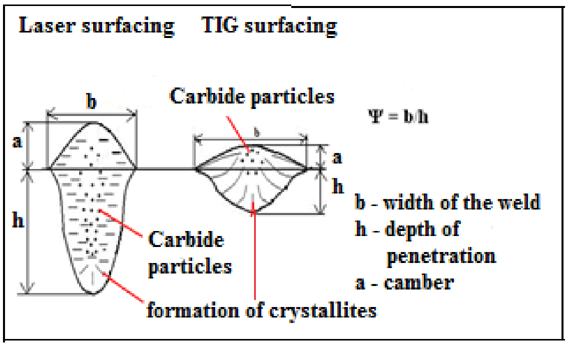

Fig. 1.Different indexes of surfacing form

Table 1. The chemical composition

Base material P355NL1	C	Mn	Si	S	P	Cr	Ni	Cu	Al
	0,18	1,4	0,40	0,050	0,035	0,30	0,30	0,30	0,010
Filler material wire PZ 6159	C	Mn	Si	Co	Mo	Cr	V	W	-
	0,40	1,10	1,10	2,00	0,40	1,80	0,40	8,00	-
Filler material powder WC/Co	WC	Co	-	-	-	-	-	-	-
	88	12	-	-	-	-	-	-	-

2.1. Experimental programme design

Within the experimental programme, two surfacing technologies were used: laser surfacing and surfacing with tungsten inert gas. These technologies were selected on the ground of very different index of surfacing form Ψ (Fig. 1). In dependence on selected technology and surfacing parameters, weld pool crystallization and composite distribution in the volume of weld beam and surfacing as a whole were observed.

2.2. Testing methodology

Following tests were selected: REM analysis, hardness test, abrasive wear resistance test according to STN 015084.

REM analysis

With the help of the scanning electron microscope, the amount and deposition of wolfram carbide in individual surfacing were observed. Using TIG and laser surfacing, they were surfaced by filler material in the form of tubular wire PZ 6159. Carbide particles originated in the process of crystallization from weld pool.

Carbide particles were added directly to the process during laser surfacing using the filler material in the form of powder.

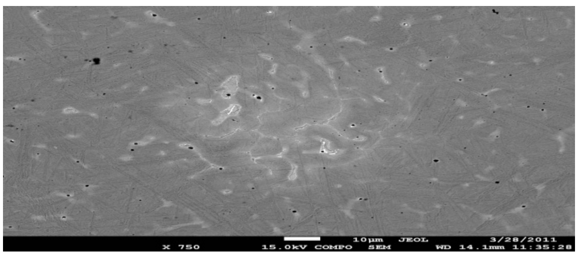

Fig. 2. TIG surfacing PZ 6159 – zoom 750x

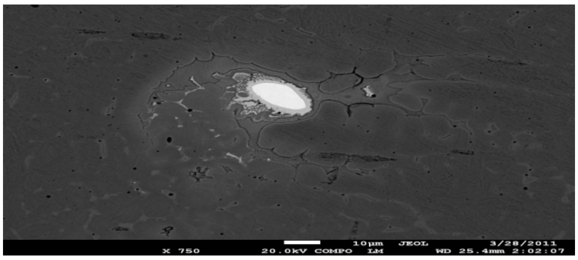

Fig. 3. Laser surfacing PZ 6159 – zoom 750x

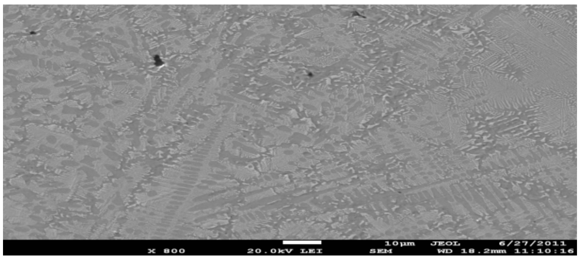

Fig. 4. Laser surfacing WC/Co – zoom 800x

Hardness test

By this measuring, the hardness of individual structural areas was observed to define their properties.

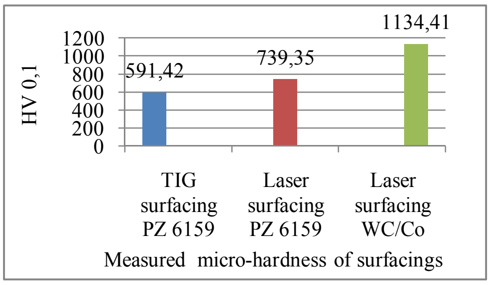

Fig. 5. Measured micro-hardness of surfacing

Indenters were pressed into the sample with the help of diamond point. Measuring was carried out in the following manner – advance by 0.5 mm through the surfacing to the base material in each sample.

Abrasive wear resistance test

This test was carried out according to STN 015084. Before wear resistance measuring, the samples were individually weighed using electronic weight with an accuracy of 10^{-3} g. After weighing, the sample was fixed in the holder of testing device and it was loaded by compressive force of 0,25 N. Sample moved radially from the border to the middle, where it was automatically stopped, picked and cleaned. Abrasive cloth was changed and another sample was applied. Standard reading $W_{opz} = 0.3572$ g was gained after abrasive wear of the sample from the material 12 014.20 the way it is specified by STN 41 2014. After the tests, the samples were weighed again. Weight decrease and relative abrasive wear resistance were figured out from the measured values:

- TIG surfacing PZ 6159 - Ø $\Psi_{abr} = 1.4889$
- Laser surfacing PZ 6159 - Ø $\Psi_{abr} = 1.2662$
- Laser surfacing WC/Co - Ø $\Psi_{abr} = 2.6928$

3. OBTAINED RESULTS

Goal of this work was to study and affect distribution of carbidic particles in the surfacing using two different surfacing technologies with different surfacing form index and testing of two filler materials.

Experimental research began to carry out in the cooperation with First welding company, Inc. in Bratislava. TIG technology was used for surfacing using the tubular Ø 1.6 mm wire mechanised feed, which was also used during disc laser surfacing TruDisk 8002. With the help of this laser, wolfram carbide powder with cobalt addition was surfaced to the base material, too.

3.1. List of results

Laser and TIG surfacings surfaced by PZ 6159 were analysed by REM analysis. During this analysis was found: in surfacings with wire feeding rate ($v_{dr} = 30$ mm.s^{-1}), system of carbidic particles is more visible; this is caused by higher amount of the filler material in the process, but with the number of non-refused particles 1 – 2 WC at the size of 50 µm maximum. For better identification, it would be necessary to analyse the surfacings by transmission electron microscopy. In surfacings with the filler material in the form of powder, it is possible to observe regular grid of equally distributed powder, which is caused by selected surfacing parameters and powder granularity (45 µm).

Measured micro-hardness was different in individual surfacings. Following the results, it is possible to say that: in used filler material in the form of tubular wire using both technologies, the average micro-hardness was figured out from 495 to 740 $HV_{0,1}$. Micro-hardness reached the highest figures in laser cladding using this wire. Values of micro-hardness across the surfacing were quite equal. They gently rose and fell equally throughout the whole surfacing. High micro-hardness occurred in the surfacings that were surfaced by laser and the filler material in the form of powder. Significant increasing and decreasing of micro-hardness values shows that carbidic particles with high micro-hardness value occurred during the measuring. In these surfacings and following the measuring results, it is possible to say that higher amount of carbidic particles is concentrated on the surface and in the root of surfacing.

Breach of surface layers was observed with the help of abrasive wear resistance test. Best resistance was reached in those surfacings which had been made out using laser cladding with WC/Co powder. Sample surfaced with the highest amount of powder reached the highest wear resistance (Ψ_{abr} = 2,6928), almost perfect surface after wearing. This is due to high micro-hardness measured on the surface and the amount of wolfram carbide particles distributed in the surfacing.

3.2. Sections and topics

Thematic sections and topics of papers are listed below:

PRODUCTION ENGINEERING

Advanced Manufacturing Technologies, Industrial Logistics, Product Design, Product Development

4. CONCLUSIONS

Using the selected surfacing technologies, it is possible to reach the conclusion that more equal setting of the composite is reached in laser surfacing by wire, concerning reached micro-hardness and abrasive wear resistance. Under high performance of laser, hard structures occur. These structures are distributed equally throughout the cross-section and it was not possible to control the process and distribution of composite in the surfacing. Good results were reached in laser surfacing using the filler material in the form of powder where, following the results, it is possible to say that in greater powder flow into the process, carbidic particles set in the top of the surfacing and in its root. As a disadvantage was considered the fact that the part of carbidic particles was re-fused and it was not possible to observe the exact amount of non-refused particles in the process. However, these surfacings reached very high hardness and abrasive wear resistance.

5. ACKNOWLEDGEMENTS

This piece of work originated thanks to the cooperation with First welding company, Inc. I would like to express my sincere gratitude to Ing Frantisek Kolenic PhD, who mediated and supervised surfacing in this company.

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Comparison of strategies for measuring flatness by means of CMM

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Abstract

Paper deals with some extraction strategies for flatness measurement. It presents some measuring and evaluating data in practice, simultaneously. These values were experimentally obtained by flatness measurement by means of coordinate measuring machine. There was an outer plane surface measured by means of more flatness extraction strategies. In behalf of these extraction strategies there were a scanning methods and also a multi-point methods applied. In the course of these methods there were a variously number of points applied and there were the different points arrangement in the case of flatness measurement by multi-point methods applied, too. A measured flatness values that were obtained by means of more applied flatness extraction strategies provide possibility to an applied strategies comparison. The flatness measurement by means of the one of the scanning methods was considered to be the reference measurement – the measurement with whose results there were the other flatness measurement by means of the other extraction strategies results compared. At the conclusion there are the measured flatness values analysed and by means of a good references for a choice of optimum extraction strategy in the course of flatness measurement by using the coordinate measuring machine commented.

Keywords: Flatness; Measurement; Extraction strategy; Multi-point method; Scanning method; Coordinate measuring machine (CMM).

1. INTRODUCTION

The standard STN EN ISO 1101: 2006 [1] defines the term “flatness tolerance” as a zone that is delimited by two parallel planes with their radial distance equal to value “t”. It appears from this that flatness tolerance determines a limit values of surfaces and of planes and lines symmetries straightness deviations on a flat surface [2]. There is an urgent request of general need for obtain a measured plane surface that is replaced by profiles or points arrangement and then this surface can be faced with plane (perfect surface) whose position compared with a surface under consideration it is necessary to specify correctly at which a normal size of both surfaces difference is presented as the flatness deviation.

Plane that is faced with measured surface we called that “reference plane”. This is defined as associated plane fitting the flatness surface in accordance with specified conventions, to which the deviations from flatness and the flatness parameters are referred. Reference plane can be:

1. *Minimum zone reference planes MZPL:* two parallel planes enclosing the flatness surface and having the least separation;
2. *Least squares reference plane LSPL:* plane such the sum of the squares of the local flatness deviations is a minimum [3].

On the present the development of machine-industries measuring accuracy technique with its electronic equipment and the growth of software possibilities make them possible more and more to approximate to a geometrical properties definitions in the course of an accuracy to form inspection (i.e. flatness, cylindricity) [4].

The surface of a plane is an area that can be thought of as the combination of two profiles where the directions of the two profiles can be used to establish a coordinate system for the area and so the sampling intervals along the two defined orthogonal directions need to be specified [5].

In practice, it is often difficult to achieve a complete covering of the feature of flatness given by the theoretical minimum density of points. In these situations more limited extraction strategies are employed that give specific rather than general information concerning the assessment of flatness form. These include the

- *rectangular grid* extraction strategy,
- *polar grid* extraction strategy,
- specified grid, e.g. *"Union Jack"* and *triangular grid* extraction strategies,
- *parallel* extraction strategy,
- *points* extraction strategy [6].

When scanning with a CMM the raw data must be filtered. Filtering is the smoothing of scanned data. It is recommended when you have a large number of points. There are three filter methods that are generally used in data filtering – *Gauss* or *Gaussian*, *Spline* or *2 RC* [7].

2. METHODS USED FOR EXPERIMENTAL WORK

For several extraction strategies by means of measurement by multi-point methods and by scanning methods of an outer plane surface experimental comparison there was the flatness measured on the area with its 260 x 220 mm dimensions. The flatness measurement on this area was realized by means of the coordinate measuring machine ZEISS PRISMO NAVIGATOR 5 that was controlled by means of the operating software ZEISS CALYPSO 4.4.04.01, too. Accordingly, there was a ball styli with its radius of 1 mm applied by the flatness measurement in this case. A component part`s plane surface measurement was realized at the temperature of 20° C and at the air relative humidity of 45%. An applied extraction strategies by means of the flatness measurement by multi-point and by scanning methods we can introduce as follows:

1. <u>Measurement by multi-point methods:</u>
   - *rectangular distribution of 25 points in 5 x 5 arrangement*,
   - *rectangular distribution of 50 points in 10 x 5 arrangement*,
   - *rectangular distribution of 72 points in 9 x 8 arrangement*.
2. <u>Measurement by scanning methods:</u>

   2.1<u>Parallel extraction strategy (it was realized in a direction of X-axis)</u>
   - *by means of scanning in number of 500 points*,
   - *by means of scanning in number of 1000 points*,
   - *by means of scanning in number of 2000 points*;

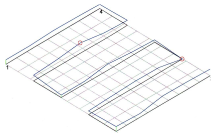
   2.2<u>Specified grid - "triangular" grid extraction strategy</u>
   - *by means of scanning in number of 500 points*,
   - *by means of scanning in number of 1000 points*,
   - *by means of scanning in number of 2000 points*.

Measured flatness values or else the acquired raw data by means of the above-mentioned extraction strategies for measuring flatness there were obtained by measuring and scanning with a CMM at first *without* their *filtering* and finally *with* their *filtering* by *Gaussian* filter and by *Spline* filter. For the acquired raw data evaluation there were adopted methods according to *Gauss* (i.e. *least squares reference plane LSPL*) and also according to *Chebyshev* (i.e. *minimum zone reference planes MZPL*).

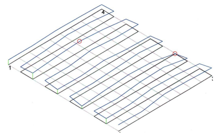
3. RESULTS AND DISCUSSION

There are the above-mentioned different applied flatness measurement methods graphical outputs those acquired raw data were obtained *without* their *filtering* and evaluated according to *Gauss* they are listed in the following Fig. 1.

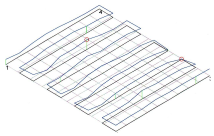
There is a single extraction strategies for measuring flatness summary of results listed in Tab. 1.



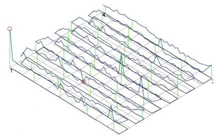
a) rectangular distribution of 25 points in 5 x 5 arrangement



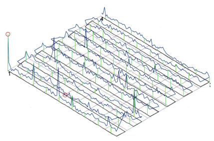
b) rectangular distribution of 50 points in 10 x 5 arrangement



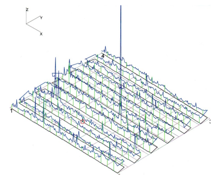
c) rectangular distribution of 72 points in 9 x 8 arrangement



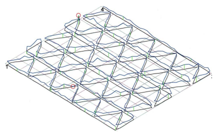
d) parallel extraction strategy in number of 500 points



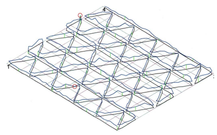
e) parallel extraction strategy in number of 1000 points



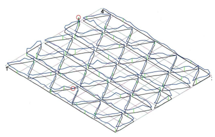
f) parallel extraction strategy in number of 2000 points



g) triangular grid extraction strategy in number of 500 points



h) triangular grid extraction strategy in number of 1000 points



i) triangular grid extraction strategy in number of 2000 points

Fig. 1. Applied flatness measurement methods graphical outputs

A single chosen extraction strategies for flatness measurement were on each other compared whereby measurement by means of triangular grid extraction strategy in number of 2000 points with *Spline* filter and evaluation according to *Chebyshev* was considered to be the reference measurement forasmuch as it is considered to be the sampling strategy for the assessment of the total feature of flatness as an alternative to the rectangular grid extraction strategy [5].

Measured flatness results that were obtained by the above-mentioned several extraction strategies for measuring flatness we can summarize as follows:

- There were the least values by means of measurement on the basis of *points extraction strategy* and they were equalled less than in compare with reference measurement. These values were in the concrete equalled 0,33 till 0,67 multiple of reference measurement value.
- In the case of measurement by means of *parallel extraction strategy* in number of 2000 points *without filter* there is an expressive failure that it can be seen in Fig. 1 f). There was a value equalled more than in compare with reference measurement. This value was in the concrete equalled 9 times more. When scanned with a CMM in numbers of 1000 and of 500 points *without filter* there were a values in the concrete equalled 2 till 2,33 times more than in compare with reference measurement.
- In the case of measurements by means of *triangular grid extraction strategies* in numbers of 2000 and of 1000 points *without*

Table 1. Flatness measurement results [μm]

Flatness measurement by multi-point methods and by scanning methods	*Without filter*		*Gaussian filter*		*Spline filter*	
	Gauss	Chebyshev	Gauss	Chebyshev	Gauss	Chebyshev
Rectangular distribution of 25 points	2	1	2	1	2	1
Rectangular distribution of 50 points	2	2	1	1	1	1
Rectangular distribution of 72 points	2	1	2	1	2	1
Parallel extraction strategy in 500 points	7	6	3	3	3	3
Parallel extraction strategy in 1000 points	6	6	3	3	3	3
Parallel extraction strategy in 2000 points	27	27	3	3	3	3
Triangular grid extraction strategy in 500	3	3	2	2	2	2
Triangular grid extraction strategy in 1000	4	4	3	3	3	3
Triangular grid extraction strategy in 2000	7	6	3	3	3	3

filter there were a values equalled more than in compare with reference measurement. These values were in the concrete equalled 1,33 till 2,33 times more. There were the least values by means of *triangular grid extraction strategies* in number of 500 points with *Gaussian* and with *Spline* filters and they were equalled less than in compare with reference measurement. These values were in the concrete equalled 0,67 multiple of reference measurement value.

4. CONCLUSIONS

From these results there are these statements possible to observe:

- There are the acquired flatness values by means of *points extraction strategy* resulting from the ultralow density of measured points. In despite of their uniform arrangement on the area there are not these measured points to recording the local flatness deviations sufficiently fast. There is an expressive expectation coming into an existence that the flatness measurement by means of this extraction strategy often checks a failure part in a good part. Therefore, even according to the standard STN P CEN ISO/TS 12781-2: 2008 [5] the *points extraction strategy* is not recommended unless only approximate estimates of the flatness parameters are required.
- Moreover, there is an application of the acquired raw data filtering more consequential. In the case of measurement by means of *parallel extraction strategy* in number of 2000 points *without filter* there is an expressive failure that it can be seen in Fig. 1 f). Therefore, there is an urgent request of general need for remove this result from additional obtained values processing or else there is also an urgent request of general need for the acquired raw data *filtering*. This high measured flatness value was to 9 times less than in compare with reference measurement value decreased at of both *filters* and of both *evaluation methods*. There is an expressive expectation coming into an existence at the evaluation of the measured data *without* their *filtering* that the flatness measurement by means of this extraction strategy often checks a good part in a failure part.
- In the case of measurement by means of *triangular grid extraction strategy* when scanning with a CMM there is too appropriate of points arrangement and also a sufficiently points density on the measured area. According to the standard STN P CEN ISO/TS 12781-2: 2008 [5] it does give the extraction strategy the ability to assess the harmonic content in the directions defining the triangular grid relative to the form content, too. There is not a flatness measurement density by an expressive failure. Hence, it may be to take this extraction strategy into the consideration as a suitable and an accuracy flatness measurement, too. There is an expressive expectation coming into an existence that the flatness measurement by means of this extraction strategy at enough high points density never checks a failure part in a good part.

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Compounding of PA12/Clay Nanocomposites

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Abstract

Due to its excellent thermal and electrical conductivity properties, nanocomposites are increasingly attracting the interest of scientists in various fields from packaging, automotive and all to the application in biomedicine. Nevertheless, until recently their use in science was very poorly. An overview of nanofiller types used in the manufacture of polymer nanocomposites is given in the paper as well as a review and classification of procedures of polymer nanocomposites manufacture. An influence of compounding time on polymer nanocomposites degradation is shown in the experimental part of this paper.

Keywords: Nanocomposites; Melt intercalation; Compounding time.

1. INTRODUCTION

Seeking for new materials with better properties, scientists are lately more and more dealing with nanocomposites.

By definition, the nanocomposites are materials in which at least one phase is in nanometer dimensions, whereby is achieved higher specific interfacial area. Therefore the properties of obtained nanocomposites depend more on interactions at the phase boundary than on the phase itself [1].

Depending on the matrix type, nanocomposites are divided on: polymer, ceramic, metal.

2. POLYMER NANOCOMPOSITES

The term polymer nanocomposite usually refers to the system in which the polymer matrix filler is dispersed. A prerequisite for better properties is uniform dispersion of the nanofillers in a polymer matrix. Typical nanofiller / reinforce filler includes: layered filler (with nanometer layer thickness and sheet structure, fibre reinforcing filler (carbon nanotubes and nanofibres) and nanoparticles (SiO_2 nanometre dimensions particles) [2].

2.1. Polymer / Layered Silicate Nanocomposites

For decades, the clay minerals in the sheet form of nanometer thickness are used as filler during the production of polymer nanocomposites. For this purpose, today are most commonly used natural clay minerals: montmorillonite, hectorite and saponite. The crystal structure of montmorillonite consists of two silicon tetrahedral sheets and aluminium octahedron sheet between them and therefore belongs to the 2:1 layered silicates (Fig. 1). The thickness of such layer is in the order of magnitude 1 nm and the blank between nearby layers is about 0,3 nm. The reason why the clay is used to produce nanocomposites is very high specific layer surface, more than 100 m^2 per gram, which allows, together with very small mass ratios (2-6%), uniformly dispersed filler in the polymer matrix with the large interactive matrix-filler surface that result in improvements of the obtained composite properties. The biggest challenge in getting nanocomposite reinforced with clay layers is the separation and dispersal of an individual layer in the polymer matrix.

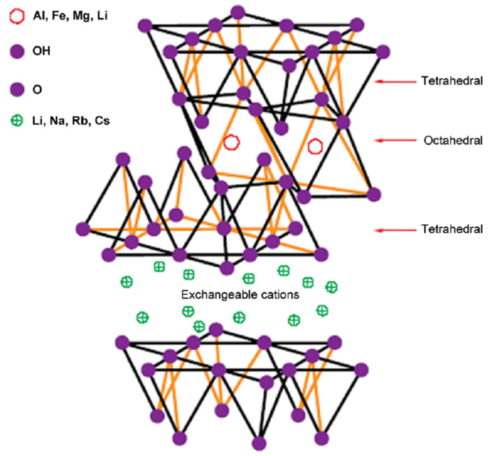

Fig. 1. The structure of a 2:1 layered silicate [3]

2.2. Polymer Nanocomposites Reinforced with Carbon Nanotubes

Unlike other carbon materials such as graphite or diamond, carbon nanotubes (CNT) are one-dimensional carbon materials where the ratio L /D is greater than 1000, and its diameter is in nanometer scale. Depending on the manufacturing process, today there are nanotubes with one (SWCNTs) or more walls (MWCNTs). SWCNTs consist of a single graphene layer rolled up into a seamless cylinder whereas MWCNTs consist of two or more concentric cylindrical shells of graphene sheets (Fig. 2B) coaxially arranged around a central hollow core with van der Waals forces between adjacent layers [4].

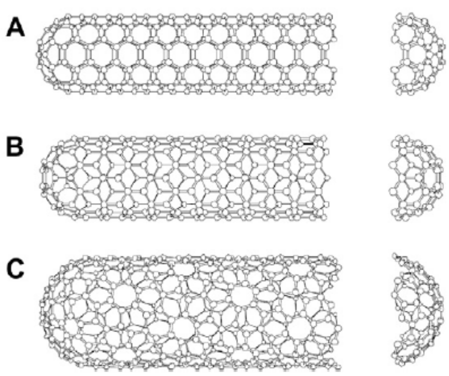

Fig. 2. Schematic diagram showing how a hexagonal sheet of graphene is rolled to form a CNT with different chiralities (A: armchair; B: zigzag; C: chiral) [4]

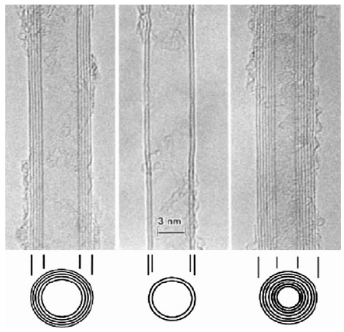

Fig. 3. TEM images of different MWCNTs with different layers of 5, 2 and 7) [4]

3. PRODUCTION OF POLYMER NANOCOMPOSITES REINFORCED WITH LAYERED SILICATES

The biggest challenge in getting nanocomposite reinforced with layered clay is the separation and dispersal of individual layers in the polymer matrix. Unless there is no separation of clay layers, common micro composite is obtained (Figure 3a). Nanocomposites with a few polymer molecules inserted in the interlayer between the clay sheets can occur depending on the strength of interfacial interactions (Figure 3b). In the above mentioned dependence can also occur stratified nanocomposite where the clay layers are completely separated and evenly dispersed in the polymer matrix (Figure 3c). Stratified polymer composite is preferred because it produces the largest matrix-filler contact area, which leads to the best nanocomposite properties.

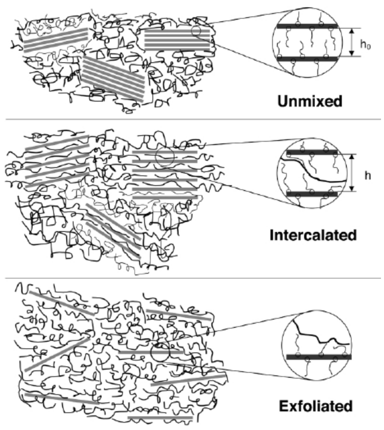

Fig. 4. Schematic diagrams of the possible layered silicate based nanocomposite structures [5]

Procedures for polymer nanocomposites preparation based on layered silicates are classified into three main groups depending on the initial materials and processing procedures [2]: Melt Intercalation, Intercalation of Polymers or Pre-polymers from Solution and In situ Polymerization.

3.1. Melt Intercalation

The procedure involves mechanical mixing of the polymer with adequately modified filler and thereafter setting the system above the polymer melting temperature (e.annealing) alongside mechanical stress (in extruder or kneader). The advantages of this procedure are that solvents are not used and it is compatible with the existing traditional industrial procedures of polymer processing such as extrusion, kneading, injection moulding. Many polymer nanocomposites were prepared by this procedure [2].

4. INFLUENCE OF MIXING TIME ON THERMAL DEGRADATION OF PA 12 /CLAY NANOCOMPOSITE

Degradation (chemical) of the polymer structure or polymer nanocomposite occurs during the preparation under the power of heat (thermal degradation) and mechanical loads. Under the influence of adducted mechanical energy, degradation significantly acts mainly as an excessive shear stress to which the material is exposed during the long processing times. The aim of this investigation is to determine the maximum nanocomposite mixing time in the extruder cylinder prior to which there will be no significant signs of damage or changed colour on the obtained nanocomposites.

4.1. Investigation Material

Material used for the nanocomposite matrix is PA12 in the powder form (made in Eos Company), known under the trade name "PA 2200 Balance 1.0". This material is used for the production of laser-sintered fully functional products, which are replacing typical injection moulding products due to their excellent mechanical properties. The main material properties are given in Table 1. Cloisite 10A of Southern Clay Products is the nanofiller used in the experiment. Cloisite 10A is a natural montmorillonite modified with a quaternary ammonium salt designed for use as an additive for plastics and rubber to improve various physical properties, such as reinforcement, CLTE, synergistic flame retardant and barrier.

Table 1. PA 2200 Balance 1.0 properties [6]

Properties	Value	Unit	Test Standard
Tensile Modulus	1650	MPa	ISO 527-1/-2
Tensile Strength	48	MPa	ISO 527-1/-2
Charpy impact strength (+23°C)	53	kJ/m²	ISO 179/1eU
Shore D hardness (15s)	75	-	ISO 868
Melting temperature (10°C/min)	176	°C	ISO 11357-1/-3
Density (lasersintered)	930	kg/m³	EOS Method

4.2. Equiment

Nanocomposite compounds are made on the laboratory twin-screw extruder HAAK Minilab that is intended to compound nanocomposites and can be used for rheological investigations. The major advantage of this device is that it works with samples of 5 gram size, so that with the small amount of polymer and expensive nanofiller can be made a lot of different compounds in a short time period and is suitable for initial investigation. The system is based on a conical, twin-screw compounder with an integrated backflow channel. Due to the channel and a bypass valve, the residence time is well defined. Two pressure transducers are integrated in the backflow channel. They allow the measurement of (relative) melt viscosity.

Fig. 5. HAAKE MiniLab twin-screw compounder

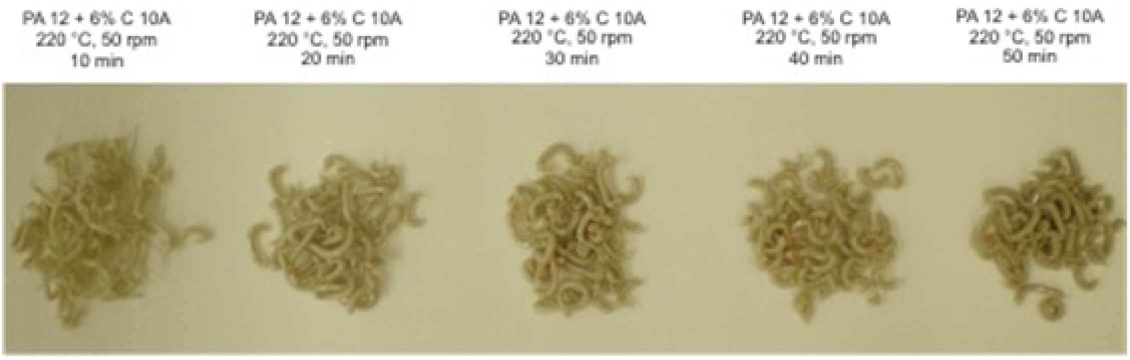

Fig. 6. Obtained samples of PA 12 / Clay nanocomposites

4.3. Investigation Design and Results

Nanocomposite compounds PA12 filled with Cloisite 10A were prepared on the twin-screw extruder for testing. All samples were prepared at the temperature 220 ° C, screw speed 50 r / min and mixing time 10-50 minutes. After obtaining samples the visual control was carried out. Compound of mixing time 20 minutes showed a mild colour change which leads to the conclusion that after 20 minutes of mixing inside the extruder cylinder comes to a small thermal degradation. Significant colour change is visible on the sample mixed for 50 minutes from what can be concluded that a large thermal degradation occurred and thus the properties of such nanocomposites are significantly reduced.

5. CONCLUSION

For its characteristic properties nanocomposites are nowadays increasingly being used in technique, and certainly will take a significant share in materials production in the future. This experiment is only a small part of the main experiment that has the aim to determine changes (improvement) in the PA12 properties reinforced with nano-clay Cloisite 10A. Also, the experiment has been conducted to detect an optimal choice of parameters (mixing time) in nanocomposite preparation. Experiment shows that after only 20 minutes of mixing the visual change on the material can be seen, while the major degradation occurs after 50 minutes of mixing. Further research will go in for mechanical tests in order to confirm that besides changes in material colour its mechanical properties also decreases.

5. ACKNOWLEDGEMENTS

These materials are based on work financed by the Croatian Science Foundation.

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Utilization of stereology for evaluation of strain in volume of formed parts

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Abstract

Mechanical working leads to final properties of formed part, which are affected by conditions of production technology. For all that it is needful to know detail structure changes of plastic deformed material caused by bulk forming. In the polycrystalline material (metal, alloy) the main microstructural parameter is grain boundary – surface interface between individual grains. Structure of nondeformed material is isotropic, the grains have isometric dimension and mean grain size or size distribution of grains and specific surface area of grain boundaries is sufficient. Forming leads to grain boundaries deformation – the structure is anisotropic. The grains have anisometric dimension and it is necessary to describe their orientation. There are a few ways how to measure grain orientation. One of the ways is scalar measurement of anisotropy – to determine degree of orientation. The anisotropic microstructure is decomposed into isotropic, planar and linear oriented components using stereology methods. But this measure required prior knowledge of the axes of orientation, which are in most of mechanical working processes known. On metallographic cut it is possible to observe grain boundaries orientation which was cased by grain boundaries deformation and it is necessary to convert grain boundary orientation degree to deformation. Conversion of grain boundary orientation degree to deformation was based on a relation orientation to deformation of idealized shape grain. From three basic equations – definition of deformation, definition of degree of orientation and invariability of volume the dependence of deformation to orientation was solved. The method was applied on upsetting and drawing technologies.

Keywords: Mechanical working; Stereology; Grain boundary; Orientation; Deformation.

1. INTRODUCTION

Mechanical working leads to final properties of forming pieces, which are affected by conditions of production technology. Recently the forming is in generally way based on macroscopic effects of deformation, but these are not corresponding fully with microscopic structural changes [1]. To obtain exact knowledge about materials structural change in the whole volume of part it is necessary to use one of microscopic or macroscopic methods, for instance methods based on acoustic emission, mikrohardnes measuring, dislocation analysis, slip band observation, micromeshes method or macroscopic screw method [2]. Quantitative description of microstructure changes induced by plastic deformation is essential to the development of analytical expressions relating structure parameters and strain in each place of material bulk. In the polycrystalline material (metal, alloy) the main microstructural parameter is grain boundary – surface interface between individual grains.

In case of isotropic structure, the grains have isometric dimension and mean grain size or size distribution of grains and specific surface area of grain boundaries is sufficient. In case of anisotropic structure the grains have anisometric dimension and it is necessary to describe their orientation.

There are a few ways how to measure grain orientation. Vector or tensor measurement is for instance orientation distribution function of normals to internal grain surface described by microstructural anisotropy tensor [3]. Another way is scalar measurement of anisotropy – to determine degree of orientation. The anisotropic microstructure is decomposed into isotropic, planar and linear oriented components using stereology methods [4]. This measuring required prior knowledge of the axes of orientation, which are in most of mechanical working processes known. Therefore measurement of orientation degree in volume of plastic deformed parts and conversion of grain boundary orientation degree to deformation was used. Estimation of strain from degree of orientation was no widely developed to recent time.

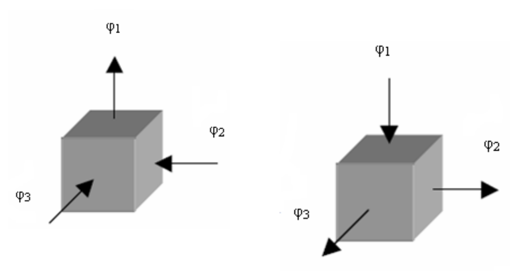
2. MEASURING METHODS

2.1. Definition of deformation

There are only three principal schemes (fig.1) of elementary bulk deformation, which very good classified strain in analysed place of forming body. They are basic indicator at analysis and evaluation deformation state caused by external load.

The scheme of deformation presented in fig. 1a relates for instance to tube drawing, $\varphi_1>0$, φ_2, $\varphi_3<0$ and $\varphi_1= - \varphi_2 -\varphi_3$, in case when $\varphi_3= \varphi_2$ (for instance wire drawing) $\varphi_2 = \varphi_3 = -\varphi_1/2$. The scheme of deformation presented in fig. 1b relates for instance to combination drawing and rolling, $\varphi_1<0$, φ_2, $\varphi_3>0$ and $\varphi_1= - \varphi_2 - \varphi_3$, in case when $\varphi_3 = \varphi_2$ (for instance upsetting, rolling) $\varphi_2 = \varphi_3 = -\varphi_1/2$. The third scheme of deformation (presented in fig. 1a when $\varphi_3 =0$) relates for instance to bending, $\varphi_1>0$, $\varphi_2<0$ and $\varphi_1= -\varphi_2$. True (logarithmic) strain φ is defined from its dimension before deformation l_0 and after deformation l and from relative strain ε as

$$\varphi = \int_{l_0}^{l} \frac{1}{l} dl \qquad \varphi = \ln(1+\varepsilon) \qquad \varepsilon = \int_{l_0}^{l} \frac{1}{l_0} dl \tag{1}$$



a *b*

Fig. 1. Principal schemes of elementary bulk deformation

2.2. Orientation measurement

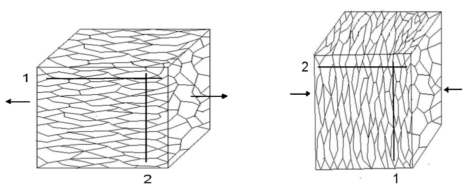
Direction of grain boundaries orientation is the same as direction of deformation. If deformation scheme is known, grain boundaries can decomposed into isotropic, planar and linear oriented components. Saltykov stereology methods with oriented test lines were used [5]. In case linear deformation, for instance wire drawing (fig. 2a – deformation direction marked by arrows), grain boundaries orientation can be observed in a plane parallel to drawing direction (according deformation scheme fig. 1a parallel to φ_1) - linear orientation, in case of rolling or upsetting (fig. 2b - deformation direction marked by arrows) in a plane perpendicular to deformation plane (according deformation scheme fig. 1b parallel to φ_1) - planar orientation. On a metallographic cut test lines are placed perpendicular and parallel to the grain boundaries orientation direction effected by straining. From the relative number (number to unit of length) of parallel test lines (1 in fig 2) intersections with grain boundaries $(P_L)_P$ and perpendicular lines (2 in fig 2) ones $(P_L)_O$ was total relative surface area (area to unit test volume) $(S_V)_{TOT}$ of grains estimated - according equation (2) in case planar orientation and according equation (4) in case linear orientation. Planar oriented part of relative surface area $(S_V)_{OR}$ of grains was estimated according equation (3), linear oriented part according equation (5). Degree of grain boundaries orientation was estimated as $(S_V)_{OR}$ to $(S_V)_{TOT}$ ratio.

$$(S_V)_{TOT} = (P_L)_O + (P_L)_P \tag{2}$$

$$(S_V)_{OR} = (P_L)_O - (P_L)_P \tag{3}$$

$$(S_V)_{TOT} = \frac{\pi}{2}(P_L)_O + \left(2 - \frac{\pi}{2}\right)(P_L)_P \tag{4}$$

$$(S_V)_{OR} = \frac{\pi}{2}\left[(P_L)_O - (P_L)_P\right] \tag{5}$$



a *b*

Fig. 2. Anisotropic structure due to various types of deformation- linear a, planar b

3. RESULTS AND ACHIEVEMENTS

Conversion of grain boundary orientation degree to deformation was based on similar comparison orientation – deformation of idealized grain shape. From three basic equations – definition of deformation (6), definition of degree of orientation (7) and invariability of volume (initial volume is equal volume after deformation) (8) the dependence of deformation (ε and from it φ) to orientation (O) was solved. Two types of deformations /orientations were analysed – linear and planar. Linear deformation ($\varepsilon > 0$) leads to linear orientation (degree of orientation O_L), planar deformation ($\varepsilon < 0$) leads to planar orientation (degree of orientation O_P). If O_L, $O_P=0$, $\varepsilon = 0$, if $O_P=1$, $\varepsilon = 1$, if $O_L=1$, $\varepsilon = \infty$.

Let isometric double cone with radius R and high 2R (each cone R) after linear deformation (tension) and planar (compression) deformation will has high 2h, radius r and side s. The basic equations are

$$\varepsilon = \frac{h-R}{R} \qquad (6)$$

$$O = \frac{2\pi rs\frac{h}{s} - 2\pi rs\frac{r}{s}}{2\pi rs} = \frac{h-r}{\sqrt{h^2+r^2}} \qquad (7)$$

$$\frac{2}{3}\pi r^2 h = \frac{2}{3}\pi R^3 \qquad (8)$$

where orientation $O=O_L$ in case of linear orientation and $O= -O_P$ in case of planar orientation. The solving leads to relation of strain to orientation degree (9)

$$\varphi = \ln\left(\frac{1+O\sqrt{2-O^2}}{1-O^2}\right)^{\frac{2}{3}} \qquad (9)$$

Solving equations for idealised grain shapes (for instance also for sphere, cube, isometric cylinder) leads to independence of results on initial dimension of grain – strain depends only on shape of grain and not dependents on its dimension.

The results were applied on experimental specimens. Cylindrical bar tensile test specimen from 16MnCr5 steel (1.7131) after linear deformation and cylindrical bar from S235JRG1 steel (1.0036) after planar deformation (upsetting) were analysed. For measurement grain boundaries orientation degree stereology methods oriented test lines was used, for conversion grain boundaries orientation to deformation the derived model of dual cone idealized grain shape was used. Experimental result of measurement of linear and planar deformations showed relatively good coincidence between true strain of microstructure and macroscopic deformation calculated from dimensions of samples.

For illustration measured values of true macroscopic deformation φ_m and linear orientation O_L and calculated true strain of microstructure φ_l in the margin and in the centre of specimen are in table 1.

Table 1. Measured and calculated values of linear orientation and deformation

place	φ_m	O_L	φ_l
center	0,14	0,134	0,134
margin		0,139	0,137

It indicates that the conversion model of grain boundary orientation degree to true strain is relatively effectual. It not excepted eventually using more optimally grain shape model [5].

4. CONCLUSIONS

The utilization of sterology metallography allow very simple and effective experimental estimation of plastic deformation degree by measure of grain boundaries orientation in various places of formed parts even at the surface layer deformation at the metal spinning process [6] or drilling [7]. Estimation of grain boundaries orientation degree and consequential conversion of its values to true strain lead to determination of deformation in three main axes and from these values an effective strain. Such results are very needful not only for effective technology application, but for instance for verification of bulk forming numerical model by comparing this results with numeric simulated results of effective strain using finite elements method. Conversion of grain boundary degree orientation to grain deformation is independent on initial dimension of grain – strain depends only on shape of grain and not dependents on a grain dimension. This method also can be used for measurement of formed parts with arbitrary value of initial deformation, because true strain is aditive. For instance method based on the comparison of relative surface area of grain boundaries in deformed state and undeformed state [8] requires knowledge of the parameter of structure with zero value of initial deformation.

5. ACKNOWLEDGEMENTS

The results presented in the paper are based on investigation of international research project “Multivariate optimization of the metal spinning processes – research and development“ project MANUNET-2008-SK-001.

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Issue of 5 - axis milling

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Abstract

The article deals with 5 - axis milling. This milling method is currently used in the manufacturing of complex shaped parts. 5 - axis milling achieves increased accuracy of components because the component is possible to mill from five sides at one clamp. Description of 5 - axis milling machines structures is also mentioned as well as equations for the calculation of important parameters of a hemispherical milling cutter. These parameters are adjusted for 5 - axis milling. Finally, effective cutting speed and effective feed rates exploitation in practice are summarized.

Keywords: 5 – axis milling; Structures of milling machines; Effective cutting speed; Effective feed rate.

1. INTRODUCTION

In the past, parts were produced from stock with simple shape (cylinder, prism, etc.). Surfaces were machined on conventional machine tools. This most often requires a simple linear linkage of the two movements, which can by provided by mechanical way (for example rotation and translation in turning of a cylinder). Complex shaped surfaces are machined at nowadays [1]. These shapes are known in the literature as FFS (Free Form Surfaces). These shapes can't be described analytically easily. Parts with FFS are effectively produced with production technologies like injection, blowing, precision casting, precision forming, forging, pressing and other. For these technologies it is necessary to produce tools. They are: foundry models and molds, forging dies, forming tools and injection molds.

FFS are now produced on a CNC milling centers, therefore it is possible to produce whole shape on one machine tool in one clamping. The most widely used are 5 - axis milling centers. Components are designed in a CAD system.

Design the part according to application methods is important [2]. This relates to the possibility of component production, consequently to a tool moves during operation [3]. Program for CNC machine tool is generated in CAM system [4]. Machine tool, tools, or machined surface may be damaged, therefore the program must be simulated and debugged [5]. Thanks to that it is possible to avoid collisions.

Basic structures of 5 - axis milling centers as well as equations for the calculation of important parameters of a hemispherical milling cutter are described in this article. These parameters will be applied to the 5 - axis milling. Finally, effective cutting speed and effective feed rates exploitation in practice are summarized.

2. STRUCTURES OF 5 – AXIS MILLING CENTERS

All structures of machines are inventions, which started according to the industrial needs [6]. Tool movement in space distinguish two phases [7]:

1. positioning – is reference point displacement (e.g. centre of gravity) from one spatial position to another,
2. directioning – is the spatial angular orientation of the tool eventually of the workpiece to a reference point.

Universal structure of a machine tool has six degrees of freedom [8]. It is able to move the tool at any position in space. When rotary tool is used in machining (milling), machine`s structure has five degrees of freedom. In practice it means control of five (5D) machine`s axes. In general, 5D axis layout of the machine`s structure can be realized in three ways:

- translational movement provides tool positioning and rotational movement provides workpiece`s positioning. The tool moves translational in axes X, Y, Z and workpiece is rotated around two axes; A, C (Fig. 1),

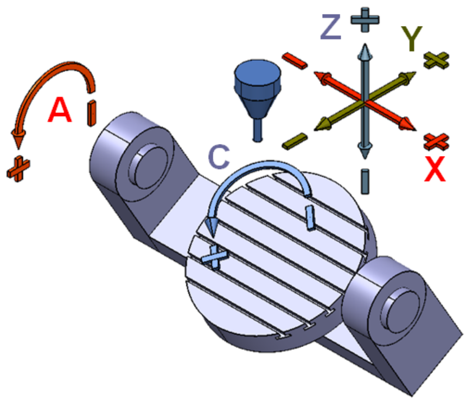

Fig. 1. 5D machine structure with swivel rotary table

- *rotational movement provides tool directioning and translational movement provides workpiece positioning. The tool is rotated around two axes and workpiece moves translational in axes X, Y, Z (Fig. 2),*
- *various combination of the two previous cases (Fig. 3).*

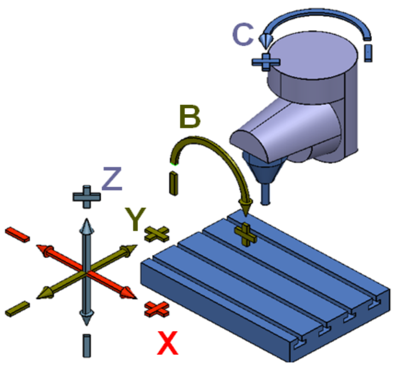

Fig. 2. 5D machine structure with tool rotation in two axes

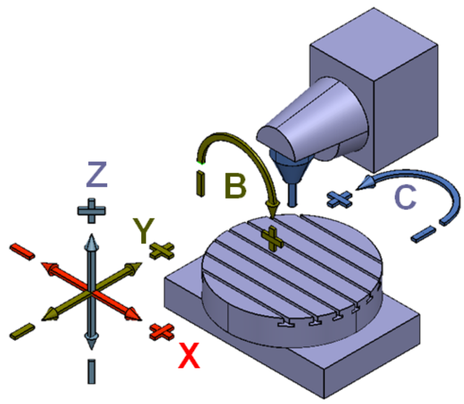

Fig. 3. 5D machine structure with tool rotation and workpiece rotation

According to practice requirements, where more and more FFS are machined, application machines with 5D structure is increasing. Various shapes, for example engine rotors, turbine wheels with blades of various shapes are produced on 5D machine tools (Fig. 4).

Fig. .4. Turbine wheel blades

3. 3 AND 5 – AXIS MILLING WITH HEMISPHERICAL CUTTER

When milling FFS, combination of different surfaces are machined. Surfaces form the final shape of the product. Surfaces can be milled either upward or downward [9]. The most applied milling strategy in 5 – axis milling is "constant Z". It is a longitudinal milling where the cutter can move up or down. Longitudinal upward milling is in Fig. 5.

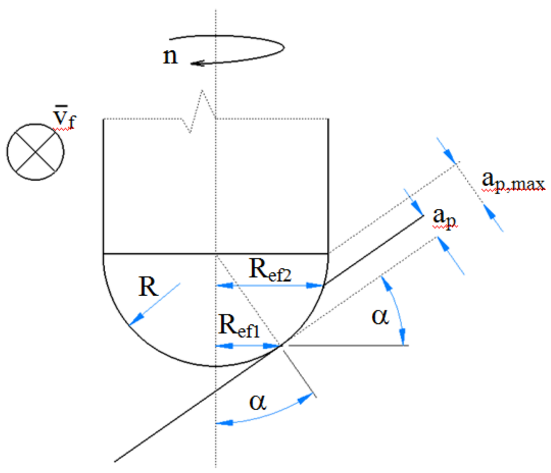

Fig. 5. Longitudinal upward milling

The situation for longitudinal downward milling is in Fig. 6.

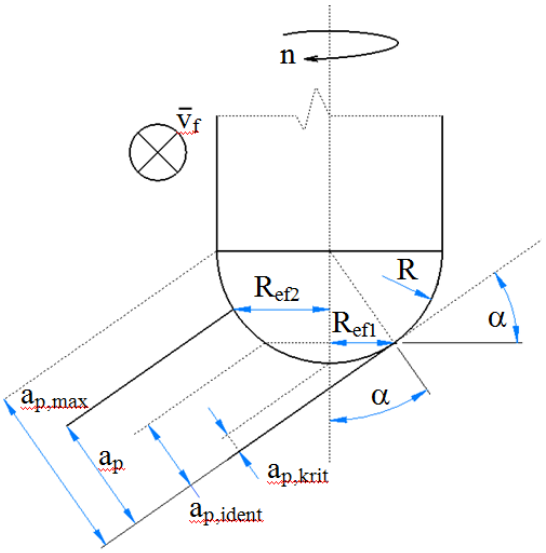

Fig. 6. Longitudinal downward milling

The symbols in figures:

a_p – depth of cut [mm],
R – radius of the cutter [mm],
v_f – feed rate [mm . min^{-1}],
α – slope angle of milling surface [°],
R_{ef1} – effective radius of the cutter at machined surface [mm],
n – frequency of spindle rotation [min^{-1}],
R_{ef2} – effective radius of the cutter at machined surface [mm],
$a_{p,max}$ – maximum depth of cut [mm],
$a_{p,ident}$ – identical depth of cut [mm],
$a_{p,krit}$ – critical depth of cut [mm].

Equations for effective radius calculation were deduced in [8, 9]. These equations are valid for 3 - axis machining. Machined surface is sloped and tool is in vertical position. Equations for calculation of R_{ef1} has the form [10]:

$$R_{ef1} = R \cdot \sin(\alpha) \qquad [\text{mm}] \qquad (1)$$

where: *R_{ef1} is effective radius of the cutter at machined surface [mm],*
R – radius of the cutter [mm],
α – lead angle of milling surface [°].

In 5 - axis milling a problem occurs. Analyze the situation for longitudinal upward milling with cutter lead angle β (Fig.7).

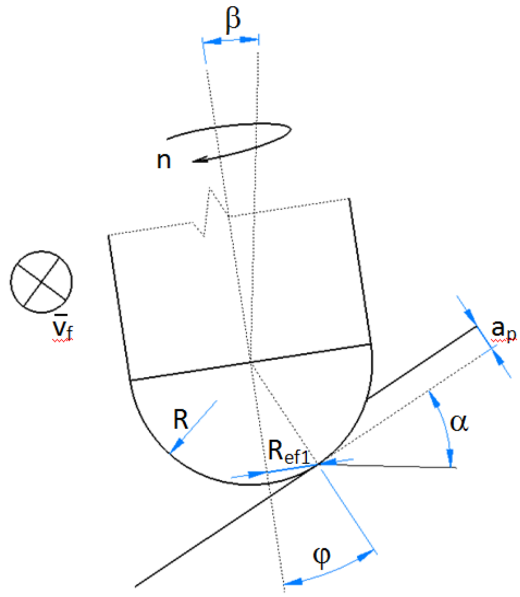

Fig.. 5. – axes longitudinal upward milling

Equation (1) for calculating R_{ef1} is not valid. It is necessary to add further parameters. It's lead angle from the vertical axis milling - β, and the contact angle of the cutter with machined surface - φ. Contact angle calculated from the equation:

$$\varphi = \alpha - \beta \quad [°] \tag{2}$$

where: φ - contact angle of the cutter with machined surface *[°],*
α - slope angle of milling surface [°],
β - lead angle from the vertical axis milling *[°].*

Then we can calculate the effective radius of the cutter at machined surface from equation:

$$R_{ef1} = R \cdot \sin(\varphi) \quad [mm] \tag{3}$$

where: *R_{ef1} is effective radius of the cutter at machined surface [mm],*
R – radius of the cutter [mm],
φ - contact angle of the cutter with machined surface *[°],*

4. EFFECTIVE CUTTING SPEED AND EFFECTIVE FEED RATE IN PRACTICE

In technical practice is common, that parts has different surfaces, thus the value of effective radius will also change. This also changes the value of instantaneous effective cutting speed. We calculate this value from the equation:

$$v_{c,i} = \frac{2\pi \cdot R_{ef_i} \cdot n}{1000} \quad [\mathrm{m.min^{-1}}] \tag{4}$$

where: *$v_{c,i}$ is instantaneous effective cutting speed [m.min^{-1}],*
$R_{ef,i}$ – instantaneous effective radius [mm],
n – frequency of spindle rotation [min^{-1}].

In milling of FFS parts constant *instantaneous effective cutting speed* $v_{c,i}$. is required Hence we need to formulate instantaneous frequency of spindle rotation n_i from equation (4). The equation is (5).

$$n_i = \frac{1000 \,.\, v_{c,i}}{2\pi \,.\, R_{ef,i}} \quad [\mathrm{min^{-1}}] \tag{5}$$

where: *$v_{c,i}$ is instantaneous effective cutting speed [m.min^{-1}],*
$R_{ef,i}$ – instantaneous effective radius [mm],
n_i – instantaneous frequency of spindle rotation [min^{-1}].

In programming of CNC machine tools; in the NC code the frequency of spindle rotation is presented as S. If we know the value of instantaneous slope angle of milling surface α_i and lead angle from the vertical axis β, we can calculate instantaneous frequency of spindle rotation n_i that will be used in the NC program. Thanks to that constant cutting speed is achieved for milling whole surface and consequenlty the constant surface roughness is ensured.

Frequency of spindle rotation is closely related to the feed rate, therefore it is possible to calculate required feed rate at a moment according to equation:

$$v_{f,i} = f_z \, z \frac{1000 \cdot v_{c,i}}{2\pi R_{ef_i}} \quad [\mathrm{mm.min^{-1}}] \tag{6}$$

where: $v_{f,i}$ – instantaneous effective feed rate [mm.min^{-1}],
$R_{ef,i}$ – instantaneous effective radius [mm],
$v_{c,i}$ - instantaneous effective cutting speed [m.min^{-1}],
f_z – feed per tooth [mm].
z – number of teeth

5. CONCLUSION

In the paper we have traced out issues of 5 - axis milling. 5 - axis milling is very huge topic. Structures of existing machine tools, calculation of effective radius of the cutter at machined surface and using of effective cutting speed and feed rates in practice were described. The next research will be focused on derivation of the equations for the effective radius of the cutter at machined surface calculating. The current project will examine the impact of lead angle from the vertical axis milling on the dynamic characteristics of the cutting process: cutting force and its components and vibration generated in the process of 5 - axis milling. The result will be derivation and experimental verification of equations for cutting forces calculation. We will also study the issues of structures of milling machines, CAM milling strategies and their impact to the accuracy and roughness of machined surfaces. Our research is realized in a "Centre of Excellence of 5 - axis machining", where necessary machine tools and devices are located.

6. ACKNOWLEDGEMENTS

The article was written in the project of European Union Structural Funds: "Centre of Excellence of 5 - axis machining"

Tento článok vznikol vďaka podpore v rámci OP Výskum a vývoj pre projekt Centrum excelentnosti 5-osového obrábania, ITMS 26220120013, spolufinancovaný zo zdrojov Európskeho fondu regionálneho rozvoja.

Európska únia
Európsky fond regionálneho rozvoja

Operačný program VÝSKUM a VÝVOJ

Podporujeme výskumné aktivity na Slovensku/
Projekt je spolufinancovaný zo zdrojov ES

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Heat treatment influence on stud arc welding process characteristics

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Abstract

In this paper the influence of welding current and heat treatment (normalizing) on the weld joint area hardness changes at Drawn Arc Welding – DAW - process with a ceramic ferule is examined. The changes of weld joint characteristics before and after the heat treatment are investigated by micro-hardness HV0,2 measuring across the weld joint and analysing the hardened zone by presentation in diagrams and through macro and micro section analysis of weld before and after the normalising process.

Keywords: Production engineering; Drawn Arc Welding – DAW - process with a ceramic ferule; Heat treatment; Micro-hardness HV0,2.

1. INTRODUCTION

In the industries of steam generators, waste incineration boilers and furnaces the fire resistant materials for lining, like ceramic parts, fibre materials protection (isolation materials) or fire proof concrete are used. They are fixed by studs. These studs have different shapes and they are joined to steel construction. Often, for this application, studs are produced of high temperature steels resistant to flame and oxidation [1, 2, 3].

1.1. Drawn Arc Welding – DAW - process

Drawn Arc Welding – DAW - process with a ceramic ferule is pressure arc welding process that uses electric arc between stud metal and work piece for material melting. After melting the material in weld zone the pressure is applied for creating a weld joint (Fig. 1). Characteristic parameters in DAW process with a ceramic ferule are [4]:

- Stud plunge P – the length of a stud protruding beyond the ferrule.
- Stud lift L – the distance to which the gun pulls the stud away from the base material.
- Welding time t indicates the duration of the welding process.
- Welding current I – average electric current during arching after the stud has been lifted. (Arch voltage U is resulting from stud lift and welding current.)
- Polarity – during steel welding, the stud is poled "-" and the base material "+".
- Plunging speed - for welding guns without microprocessor-driven lifting of chuck.

Although the application of this welding process is possible for all materials weldable with arc welding processes the stud and base metal should be compatible. During short time burning of electric arc the stud and base metal are melted and in weld pool these two materials are mixed with phase forming in heat affected zone. In order to eliminate possible structural flaws, welds are being heat-treated to restore initial, pre-welding material properties, i.e. to reduce stresses and to produce desired microstructure in both base and additional material [6].

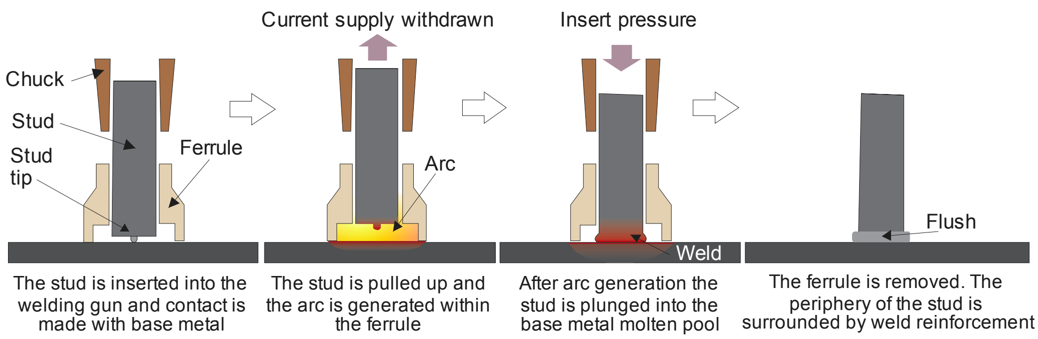


Fig. 1. Welding operation sequence for draw arc welding with ceramic ferrule [5]

1.2. Normalizing

Normalizing is the type of the heat treatment that is, in some cases, used also before, and after the welding process. The normalizing process is mostly used for elimination of possible defects that can appear during welding process. Normalizing is composed of austenitizing and cooling on calm air. This heat treatment is conducted by heating the sub-eutectoid steel part on temperature 30 to 50 K over A3, or hypereutectoid steel on 30 to 70 K over A1 (Fig. 2) and cooling on calm air [6].

In the experimental part of the paper the attention is given to influence of the normalization on weld joint characteristic at welding of dissimilar materials. The studs and the base metal (plate) used in this experiment are applied in boiler production for attaching the fire resistant materials.

2. METHODS AND MATERIALS USED FOR RESEARCH

In the experiment set-up drawn arc stud welding with ceramic ferrule was applied on equipment delivered by the manufacturer [7]. Studs marked as "Nelson KS 10,0×50" were used, protected by ceramic ferrule “Nelson KW 10/5.5”. The stud material was steel X10CrAl18 (EN 10095).

The base material plates of steel 16Mo3 (EN 10028-2) were 5 mm thick. The following variable was selected for the experiment: welding current *I*, A. (Plunge, lift and welding time were held constant: *P* = 2,9 mm, *L* = 2,5 mm and welding time *t* = 0,35 s).

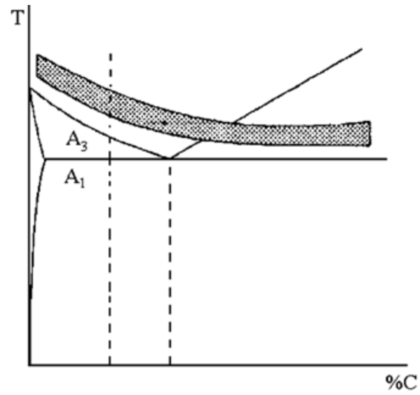


Fig. 2. Temperature area of normalizing in Fe-Fe$_3$C *diagram [6]*

The normalizing parameters had been selected in relation to the base material - 16Mo3 – steel; after heating up to 900 °C and maintaining that temperature for 30 minutes, specimens had been taken out from the oven and allowed to cool down on calm air. Table 1 shows the experimental set-up with defined parameters and specimens markings.

After the preparation of specimens, their hardness was measured using the Vickers-method. Due to small weld dimensions, a load of 2 N was selected (HV0,2). A macro cross-section with the direction of hardness measurement is given in Fig. 3. The distance between measurement points was 0,5 mm for base material and 0,25 mm in the heat affected zone and the weld zone.

Table 1. Stud welding parameters and research methods.

Welding current *I*, A	Heat treatment	Specimen No.	Type of test
500	-	1A, 1B, 1C	Hardness test HV0,2 Analysis of macro and micro structure
600	-	2A, 2B, 2C	
500	Normalising	T1A, T1B, T1C	
600	Normalising	T2A, T2B, T2C	

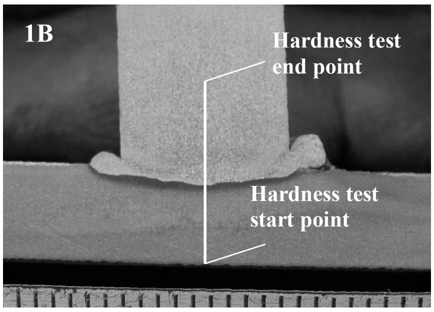


Fig. 3. Illustration of hardness measurement HV0,2 (specimen no 1B)

3. ANALYSIS OF RESULTS

A total of 6 specimens have been experimentally welded at varying currents and their respective hardness was measured. To establish a relationship between heat treatment and alteration of the hardening zone structure, the same measurement was repeated on all specimens after the heat treatment.

3.1.Weld hardness HV0,2

Comparing HV0,2 values, it is apparent that increased current causes growth of the hardness zone of the weld (examples of recorded values for the specimens 1B and 2B are given in Fig. 4).

The results of the hardness measurement after the heat treatment for the specimens T1B and T2B are shown on Fig 5. It can be observed that consequent heat treatment, specifically normalizing, decreased hardening of the particular zone in weld specimens.

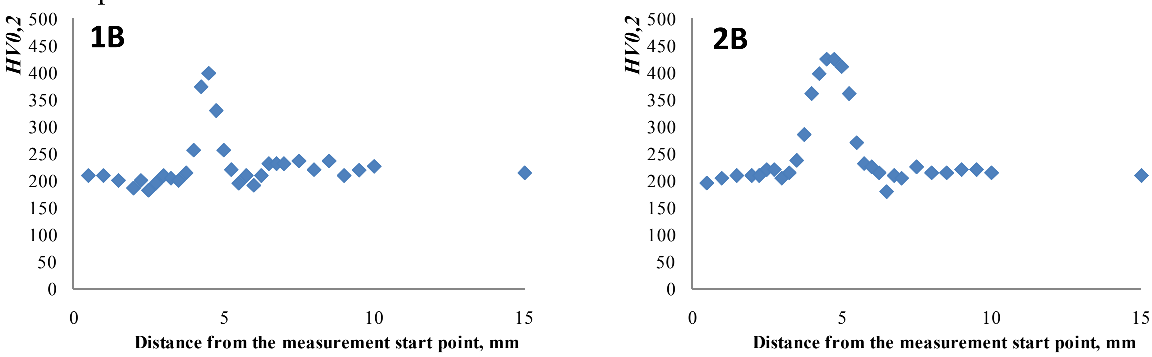


Fig. 4. Weld hardness HV0,2 for the specimens 1B and 2B

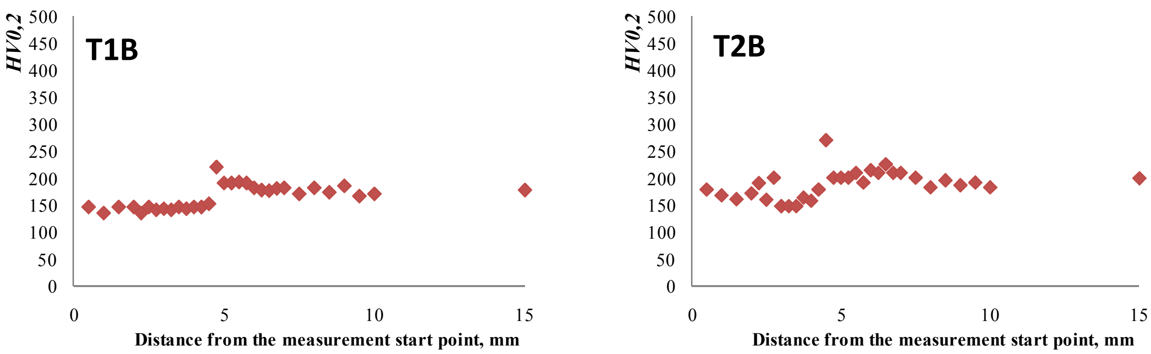
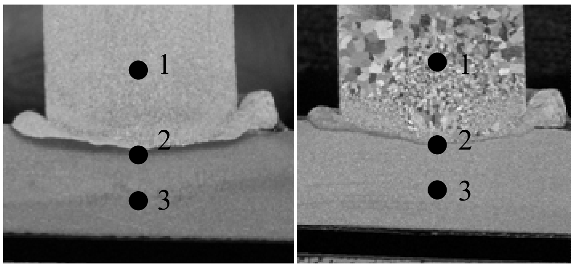


Fig. 5. Weld hardness HV0,2 for the specimens T1B and T2B

3.2. Analysis of macro and micro structure

The macro cross-sections before and after heat treatment are shown in Fig. 6 for the sample 1B. Structural changes after heat treatment are visible: the stud material exhibits grain coarsing with reduced heat affected zone size within the steel plate base.



a) Specimen 1B b) Specimen T1B (1B after heat treatment)

Fig. 6. Macro cross section of the specimen

For the sample 1B, micro structural analysis has been performed before and after heat treatment – these results are shown in Fig. 7.

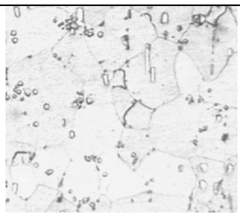
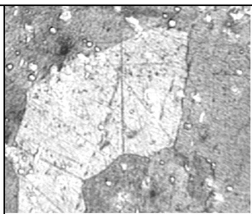
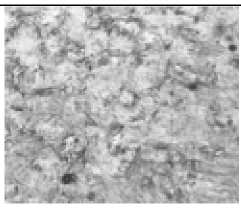
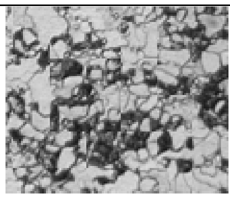
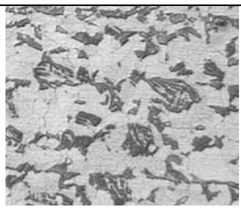
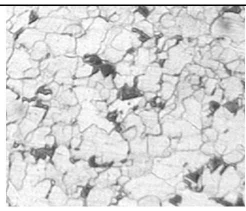
 1 (100:1, Adler)	 1 (100:1, Adler)
 2 (100:1, 2% Nital)	 2 (100:1, 2% Nital)
 3 (100:1, 2 % Nital)	 3 (100:1, 2 % Nital)
a) Specimen 1B	b) Specimen T1B

Fig. 7. Micro analysis of the welded joint before and after the heat treatment

Comparing metallographic images, it is apparent that the base metal 16Mo3 structure remains ferrite with traces of perlite (Fig. 7.3) before and after the heat treatment. The X10CrAl18 stud exhibits a relatively rough-grained ferrite structure due to normalizing (Fig. 7.1). Although the heat affected zone on the 16Mo3 exhibits structural transformation towards martensite build-up after the welding, due to heat treatment it is transformed into ferrite-perlite (Fig. 7.2).

4. CONCLUSION

After the experimental stud welding the hardness HV0,2 was measured and macro and micro structures were examined. Examinations were carried out both after welding and after consequent normalization on 900 °C. Based on the diagrams of measured hardness, the effect of welding current and heat treatment can be established. Also, by observing individual weld zone (macro and micro structure) it is possible to determine the influence of this heat treatment on the weld joint properties.

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Full Factorial Design in Gas Metal Arc Welding on Aluminium Alloy 7075

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Abstract

The 7075 alloy are heat treatable and among the Al-Zn-Mg-Cu versions provide the highest strength of all aluminium alloys. Aluminium alloy 7075, due to their low solidus temperature and wide melting rate, are not considered weldable by the gas metal arc welding (GMAW) method. This research was the study in gas metal arc welding factor that affected to mechanical properties of welding joint. The material in testing is aluminium alloy 7075 grade plate of 6 mm. thickness have been used as the base material for preparing two pass welded joints. Single V butt joint configuration has been prepared for joining the plates. The filler metal used for joining the plates is AA 5356 grade aluminum alloy and electrode diameter 1.2 mm. Argon (99.99% pure) has been used as the shielding gas and gas flow rate 19 L/mm.The full factorial design applied in to experiment. The factors used in this study variables 3 levels of voltage at 20, 22 and 24 volts, and electrode feed rate at 100, 150 and 200 mm./sec. The sample was tested by tensile testing according to JIS Z 3121: 1993 and hardness testing according to JIS Z 3101: 1990. The results showed that the voltage level and electrode feed rate has interaction to tensile strength and hardness in weld metal at P-value > 0.05. The voltage at 24 volt, electrode feed rate 150 mm./sec is the factor that induced the tensile strength to 554.12 N/mm² . The hardness at 168.23 HV induced by voltage at 24 volt, electrode feed rate 150 mm./min. As the results showed that the voltage and electrode feed rate of weld is a relationship. The welding voltage was used less than electrode feed rate. Found that the weld was being bulge, lack of fusion and lack of root penetration.This test result can be taken to be data for parameter consideration that it is used for welding and the prospective research

Keywords: Aluminium alloy; Gas metal arc welding; Mechanical property; Full Factorial Design.

1. INTRODUCTION

The heat-treatable alloys 7XXX develop their properties by solution heat treating and quenching, followed by either natural or artificial aging. The heat-treatable alloy may also be annealed to attain maximum ductility.[1] During fusion welding, the heat affected zone will be exposed to sufficiently high temperatures to overage heat-treat metal. As result, this zone will be softened to some extent.[2]

Alloy 7075 aluminum are mainly zinc-magnesium alloy systems. They both have low copper content and process good weldability. These alloys are fabricated in to such product as sporting good, military bridge and automobile bumper. There are several alloys in the series that are product especially for their high toughness. [3]

Welding parameter such current, voltage wire feed rate are the principal parameter of gas metal arc welding (GMAW) Voltage or the arc length determines the arc force. A short arc focuses the available force on a small area of the weld pool thus giving deeper penetration and narrower welds. Wire feed rate is also a contributing factor in determining penetration and weld shape. The electrode feed rate is adjusted to obtain the desired voltage for good fusion and penetration.

The optimum value variables by factorial design. Many experiments involve the study of the effects of two factor is an interaction between the factors. The advantage of factorial design can be easily illustrated. [4] The factors used in the study of the voltage and electrode feed rate can be due to two factors that have an interaction on the mechanical properties.

2. METHODOLOGY

2.1. Materials and Methods

The work material used as the test specimen was aluminium alloy 7075 grade. Plates of specimens 6 mm. thickness were used for the tests. Details of the material chemical composition are given in Tables 1

Table 1. Chemical Composition of aluminium alloy 7075 grade by weight (%)

Zn	Mg	Cu	Fe	Si	Mn	Cr	Ti
6.1	2.9	2.0	0.5	0.4	0.3	0.28	0.2

The Alloy 7075 samples were welded by using GMAW. Voltage was set 20,22 and 24 V and direct current electrode positive (DCEP). The electrode feed rate was set 100, 150 and 200 mm/sec and welding travel speeds was at 12 mm/sec. Electrode (ER5356) diameter of 1.2 mm. was used in this study. Argon (99.99%) was selected as a shielding gas with the flow rate of 19 litters / minute.

Welded samples were sectioned transversely to the weld and micro hardness testing using JIS Z 3101: 1990 [5] standard micro hardness (HV). The applied load was set at 500 g. The welding sample was tensile strength by JIS Z 3121: 1993.[6] Each condition consisted of 3 replicates.

2.2. Experimental Design

Experiments to study the main effects (Main effect), and influences together (Interaction) that affect the hardness and tensile strength. Use the experimental design is a full factorial design to be the main factors effectors affecting significantly. The study was determining the optimal conditions. The factors used in the study are as follows.

Main factor

Fix Factor; Voltage, Electrode feed rate

Blocking Factor; Travel Speed, Shielding gas, Electrode and Electrode diameter

Responded factor

Hardness and Tensile strength

Hypothesis of experimental

H0 ;$(\tau\beta)_{ij} = 0$ is Voltage and Electrode feed rate no interaction Tensile strength

H1; $(\tau\beta)_{ij} \neq 0$ is Voltage and Electrode feed rate interaction Tensile strength

and

H0 ;$(\tau\beta)_{ij} = 0$ is Voltage and Wire feed rate no interaction Hardness

H1; $(\tau\beta)_{ij} \neq 0$ is Voltage and Wire feed rate interaction Hardness

3. EXPERIMENTAL RESULT

3.1. Result of tensile strength

Tensile strength testing was the test on mechanical property of weld for measuring tensile strength which using 27 sample for each testing according to JIS Z 2241:1998.

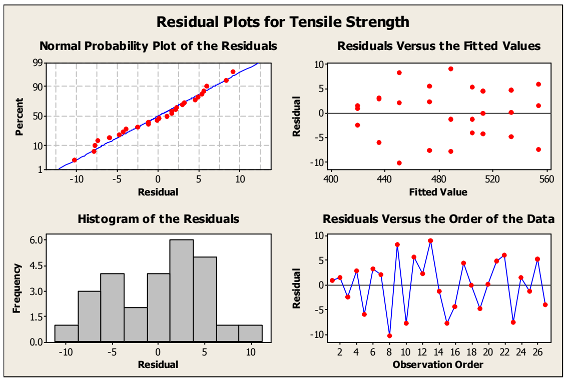

Fig. 1. Residual plot of tensile strength

Fig. 1 showed residual plot of tensile strength a typical checking data distribution. The probability of failure with normal distribution (Normal probability plot of the residuals) information obtained is a straight line. Then they must consider determining the variance constant. The data was relative value of the error and the average value of each factor (Residual versus the fitted values) and a graph showing the relationship of the error and the order of the trial (Residual versus the order of the data). The results showed that tends to randomness. It is therefore concluded that the results of tensile strength.

Table 2. General linear model: Tensile strength versus voltage and electrode feed rate

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Voltage	2	8860.3	8860.3	4430.1	751.70	0.000
Electrode Feed Rate	2	601.8	601.8	300.9	51.06	0.000
Voltage*Electrode Feed Rate	4	657.2	657.2	164.3	27.88	0.000
Error	18	106.1	106.1	5.9		
Total	26	10225.5				

S = 2.42765 R-Sq = 98.96% R-Sq(adj) = 98.50

As shown Table 2, General linear model of the tensile strength versus voltage and electrode feed rate. Found that the voltage and electrode feed rate interaction tensile strength at the level of confidence 95% (P-Value <0.05). Performance analysis of the results of the main factor is two factors. Factors could explain the variability of the response of tensile strength 98.50%

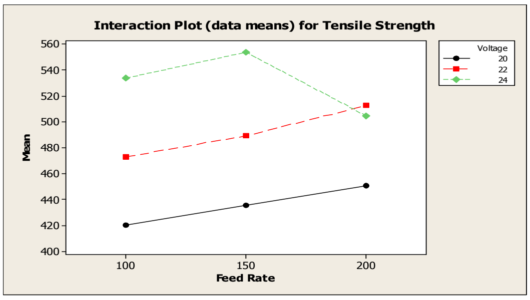

Fig. 2. Interaction plot of tensile strength

As shown Fig.4, interaction plot of hardness. Found that the voltage and electrode feed rate interaction tensile strength. The pull factors that result in a tensile strength most electrode feed rate 150 mm/sec and 24 Voltage. Factors used in the electrode feed rate and voltage of the P-Value of factors was 0.000 (<0.005). Can conclude that the electrode feed rate and voltage with electrification is interaction significance at the maximum tensile strength was 554.12 N/mm².

3.2 Result of Hardness

Mechanical property test, hardness of penetration by micro vicker hardness at weld metal, 5 points was determined from the average of 30 samples.

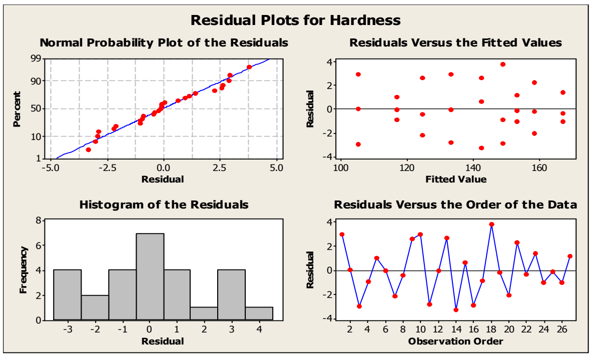

Fig. 3. Residual plot of hardness

Fig. 3 showed residual plot of hardness a typical checking normal distribution. The probability of normal probability plot of the residuals information obtained is a straight line. Then they must consider determining the variance constant. The data was relative value of the error and the average value of each factor (Residual versus the fitted values) and a graph showing the relationship of the error and the order of the trial (Residual versus the order of the data). The results showed that tends to randomness. It is therefore concluded that the results of hardness.

As shown Table 3, General linear model of the hardness versus electrode feed rate and voltage. Found that the electrode feed rate and voltage interaction hardness at the level of confidence 95% (P-Value <0.05). Performance analysis of the results of the main factor is electrode feed rate and voltage. Factors could explain the variability of the response of hardness 98.50%

Table 3. General linear model: Hardness testing versus voltage and electrode feed rate

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Voltage	2	8860.3	8860.3	4430.1	751.70	0.000
Electrode Feed Rate	2	601.8	601.8	300.9	51.06	0.000
Voltage*Electrode Feed Rate	4	657.2	657.2	164.3	27.88	0.000
Error	18	106.1	106.1	5.9		
Total	26	10225.5				

S = 2.42765 R-Sq = 98.96% R-Sq(adj) = 98.50

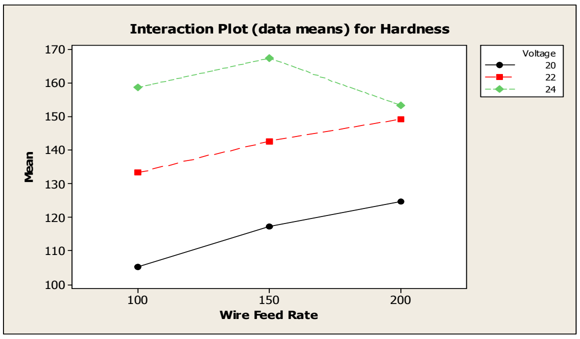

Fig. 4. Interaction plot of hardness

As shown Fig.2, interaction plot of hardness. Found that the electrode feed rate and voltage interaction hardness. The pull factors that result in hardness most electrode feed rate of 150 mm/sec and 24 Voltage. Factors used in the electrode feed rate and voltage of the P-Value of factors was 0.000 (<0.005). Can conclude that the electrode feed rate and voltage with electrification is interaction significance at the maximum hardness was 168.23 HV.

3. CONCLUSIONS

The results showed that the voltage level and electrode feed rate has interaction to tensile strength and hardness in weld metal at P-value > 0.05. The voltage at 24 volt, wire feed rate 150 mm./sec is the factor that induced the tensile strength to 554.12 N/mm² . The hardness at 168.23 HV induced by voltage at 24 volt, electrode feed rate 150 mm./min. As the results showed that the voltage and electrode feed rate of weld is a relationship. The welding voltage was used less than electrode feed rate. Found that the weld was being bulge, lack of fusion and lack of root penetration.This test result can be taken to be data for parameter consideration that it is used for welding and the prospective research

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The study of cleaning surface for resistance spot welding in aluminium alloy grade 5052

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Abstract

Aluminum - Magnesium alloys of the 5xxx series are strain hardenable, and have moderately high strength, excellence corrosion resistance even in salt water, and very high toughness even at cryogenic temperature to near absolute zero. This research was to study about the cleaning surface prior to welding that affect the completeness of resistance spot welding in aluminum alloy 5052. The experiments designs were 2 situations. The cleaning surface by mechanical method and the cleaning surface by chemical method, the welding current had 3 levels 13.5 14.5 and 15.5 kA. Moreover to test the tensile shear followed by JIS Z 3136:1999, hardness testing in accordance with JIS Z 2244:2003 and measure the grain size followed JIS Z3139:1978. The result showed that cleaning surface was to mechanical method better than the cleaning surface by chemical method. Because the cleaning surface by mechanical method was removed aluminum oxide more than the cleaning surface by chemical method. From the factor showed that the cleaning surface by mechanical method, welding current of 15.5 kA on maximum hardness and tensile shear as to minimum by the hardness at nugget of 111.3 HV. heat affected zone of 61.32 HV, tensile shear of 2.19 kN, the grain size at nugget of 9.08 µm and the grain size at heat affect zone of 9.77 µm. This research can be used as information in choosing how to prepare the surface for resistance spot resistance welding of aluminum alloy.

Keywords: Resistance Spot Welding; Aluminium Alloy; Cleaning Surface; Tensile Shear; Hardness; Grain Size.

1. INTRODUCTION

Aluminum - Magnesium alloys of the 5xxx series are strain hardenable, and have moderately high strength, excellence corrosion resistance even in salt water, and very high toughness even at cryogenic temperature to near absolute zero. They are readily welded by a variety of technique.[1]

Quality of aluminum welding depends upon cleanliness and dryness of the metal with a thin oxide film.[2] Welds of uniform strength and good appearance depend upon a consistently low surface resistance. The surface condition of as-received material may be satisfactory for many commercial spot welding. [3]Aluminium oxide estimated that a sliding displacement of only about 10 µm is required to produce a dramatic reduction in contact resistance [4]

The oxide layer, which is inherent to aluminum sheets, also plays an important role. An aluminum oxide (Al_2O_3) layer on the surface of an aluminum sheet at the as-fabricated state is usually not uniform and may break under an electrode force during welding. As a ceramic, Al_2O_3 is highly insulating with a high melting temperature. [5] A non-uniform or broken Al_2O_3 layer on sheet surface results in uneven distribution of electric current, with very high electric current density at low resistance locations, and produces significantly localized heating or even melting on the surface. [6]

This research was to study about the cleaning surface prior to welding that affect the completeness of resistance spot welding in aluminium alloy 5052. The experiments designs were 2 situations. The cleaning surface by mechanical method and the cleaning surface by chemical method.

2. METHODS AND MATERIALS USED FOR RESEARCH

2.1. Materials and Cleaning Methods

The work material used as the test specimen was aluminium alloy 5052. Plates of specimens 1 mm. thickness and 30x100 mm. fellows by JIS Z 3136 were used for the tests. Details of the material chemical composition are given in Tables 1.

Table 1. Chemical Composition of aluminium alloy 5052 by weight (%)

Al	Si	Fe	Mg	Cu	Zn	Mn
Bal.	0.04	0.21	1.88	0.5	0.005	0.01

2.2 Cleaning Methods

The cleaning surface by mechanical method and the cleaning surface by chemical method. Prepare surface by mechanical method. The sanding machine No. 120 sandpaper was used to prepare and polished with a smooth surface specimens was the same plane. Prepare the surface by chemical method chemical treatment to remove aluminum oxide surfaces on both sides of the specimen. The specimens were dipped in solution of nitric acid (HNO3) 98% for 30 sec.

2.2. Weld Method

The aluminium alloy 5052 samples were welded by using resistance spot welding. Welding current was set 13.5, 14.5, 15.5 kA and welding time 50 cycle. The electrode force was at 1.4 kN. Electrode (Truncated Radius follow by JIS C9304: 1999) contact tip diameter of 6 mm. was used in this study.

2.3. Microstructure and Mechanical properties test

Welded samples were sectioned transversely to the weld and polished using standard metallographic techniques. The nugget size and heat affected zone microstructures were examined and analyzed by an inverted reflected-light microscope equipped with the optical microscope. Grain size analysis was carried out according to JIS Z3139:1978. The specimens were micro-hardness tested. The applied load was set at 500 g. Specimen were test the strength of a weld by tensile shear testing followed JIS Z 3136:1999.

3. RESULTS AND ACHIEVEMENTS

3.1. Results of Grain size

After weld, the microstructures of heat affected zone and grain size were investigated as shown in fig. 1 and 2.

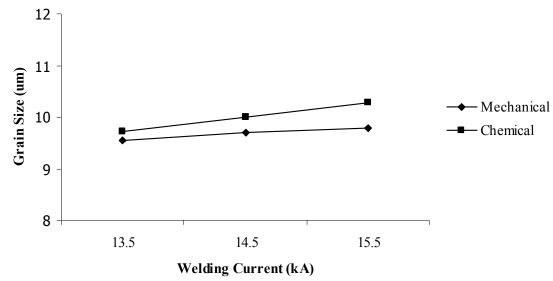

Fig. 1. Effects of cleaning methods and welding current on grain size in heat affected zone

Fig. 1 Effects of cleaning methods and welding current on grain size in heat affected zone. From the grain size tends to increase the level of current. It was found that the mechanical cleansing of the largest grain size of welding current at 15.5 kA. When electrical current were increased grain size also large. Since the molten metal by heating and then was left to cool down. The gravitational force between the molecules decreases. Due to the strong influenced of the metal in the heat of the lower side. The size of the grain is not enough time to sort themselves thoroughly it. The grain size was larger.

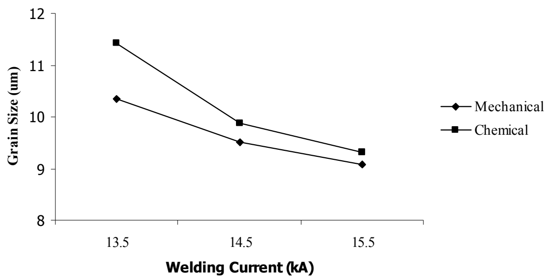

Fig. 2. Effects of cleaning methods and welding current on grain size in nugget zone

Fig. 2 showed Effects of cleaning methods and welding current on grain size in nugget zone. Grain size of the smaller increased in the welding current. Due to the greater resulted in a higher heat input. The arrangement of the grain has to be an appropriate time and temperature. The new arrangement of the grain has good resolution. Thus, when the temperature is increased, resulting in increased grain area, the Nuggets are small. Prepare the surface by a mechanical process to removed oxide from the surface than a chemical process. The heat was much more prepared to surface the process of mechanical with a small grain.

3.2. Result of Hardness

Microhardness measurements (HV) have been conducted for all joints, in order to determine the hardness properties across the heat affected zone and nugget zone region.

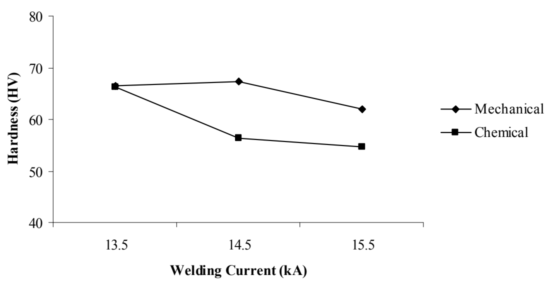

Fig. 3. Effects of cleaning methods and welding current on hardness in heat affected zone

Fig. 3 showed effects of cleaning methods and welding current on hardness in heat affected zone. Result that welding current at 13.5 kA with a maximum hardness due to a smaller grain size resulting in maximum hardness.

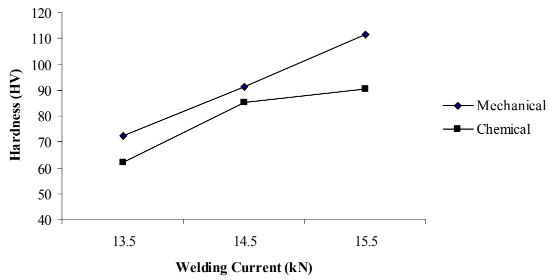

Fig. 4. Effects of cleaning methods and welding current on hardness in nugget zone

Fig. 4 showed effects of cleaning methods and welding current on hardness in heat nugget zone. Result that welding current at 15.5 kA with a maximum hardness due to a smaller grain size resulting in maximum hardness.

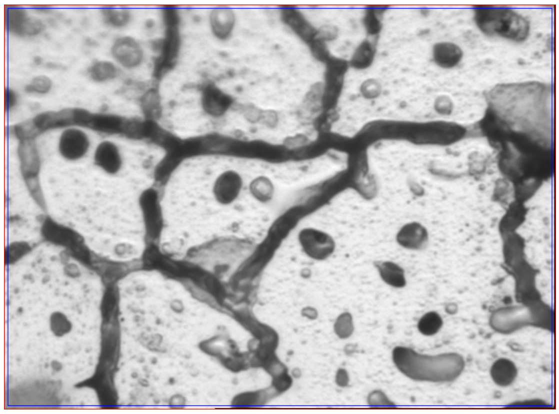

Fig. 5. Optical micrograph, showing grain boundary of nugget in welding current 15.5 kA and mechanical cleaning image size 100x

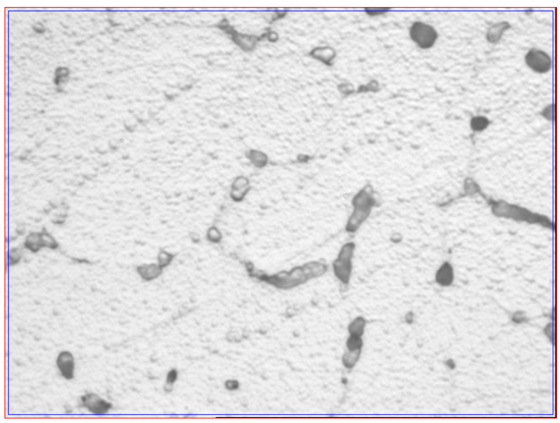

Fig. 6. Optical micrograph, showing grain boundary of nugget in welding current 13.5 kA and Chemical cleaning image size 100x

Besides grain size and also showed that the density of the Mg_2Al_3 precipitate formed at the grain boundary [7] and Mg_2Al_3distribution of parent phase show fig. 5. Fig. 6, it was found that the distribution of Mg_2Al_3 less.

3.3 Result of Tensile Shear

Tensile shear testing was the test on mechanical property of weld for measuring tensile shears which using 4 replicate per treatment for each testing according to JIS Z 3136:1999.

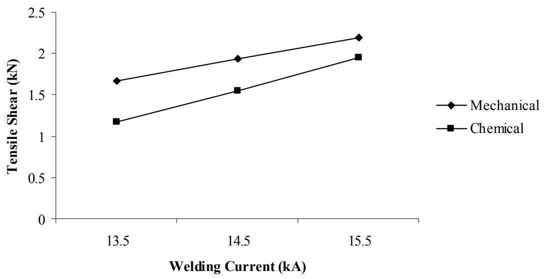

Fig. 7. Effects of cleaning methods and welding current on tensile shear

Figure 7 shows the Effects of cleaning methods and welding current on tensile shear of the joints welded under the welding current and two conditions of cleaning method. The tensile shear load of the joints increased with the increasing of the welding current. The maximum tensile shear load of 2.19 kN were obtained at welding current of 15.5 kA and mechanical method. Moreover, the fracture type of the joints varied depending on the welding current. Shear and plug fracture were observed in the heat affected zone.

Mechanical cleaning again produced the highest strength with the least variability. Chemical cleaning has lower strength and larger variability to those observed in Fig. 7 for measured tensile shear. Such differences can be attributed to the magnitude and distribution of contact resistivity of the sheets cleaned using different methods.

4. CONCLUSIONS

The cleaning surface was to mechanical method better than the cleaning surface by chemical method. Because the cleaning surface by mechanical method was removed aluminum oxide more than the cleaning surface by chemical method. From the factor showed that the cleaning surface by mechanical method, welding current of 15.5 kA on maximum hardness and tensile shear as to minimum by the hardness at nugget of 111.3 HV. heat affected zone of 61.32 HV, tensile shear of 2.19 kN, the grain size at nugget of 9.08 μm and the grain size at heat affect zone of 9.77 μm. This research can be used as information in choosing how to prepare the surface for resistance spot resistance welding of aluminum alloy.

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Cutting Temperature at Machining of Composites

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Abstract

At the present time composite materials are used in many areas of industry. The main bearing is still in the aircraft industry. Main problem at the composite materials is cutting temperature during the machining of polymer composite materials (GFRP). In paper we deal cutting temperature of sintered carbide (SC) - with AlTiN and diamond coat, - milling tools at various cutting conditions and two cooling system (cold air cooling and MQL). All experiments are designed under full factor experiments. At the end of paper we evaluate these results, illustrated in a graph and figures.

Keywords: Composite; GFRP (Glass Fibre Reinforced Plastic); Tool wear; Cutting temperature; Sintered carbide; MQL (Minimal Quantity Lubrication).

1. INTRODUCTION

The composite materials, or the composites, are the construction materials made of two or more components with significantly different physical and chemical properties. Combinating this two components we create a new material with unique properties that cannot be reached by none of these components separately neither by simply summarization [3].

As a composite it can be understood such a material that meets following conditions:

- Was made artificially,
- Consists of at least two chemically different components,
- The components have homogenous distribution throughout the volume from the macroscopic point of view,
- Consequential properties of composite are different from the properties of the individual components

These conditions exclude the natural materials (eg: wood as associated material to lignin matrix, reinforced by celluloid fibres, further bamboos, bones, etc.)

At present time the composite materials can be divided by a type of matrix and by a production method [3].

Division by a type of matrix is following:

- Polymers,
- Metallic,
- Ceramic [3].

The glass in the Mohs scale of hardness neighboures with cemented carbide, carbide of silicon and with boron carbide. Therefore all the materials besides PCD (polycrystalline diamond) will be intensively worn by the machining of glass reinforced composite materials [3].

The filler of the composite materials can be oriented differently so the material is anisotropic. The process of machining influences a binder too, as the carrying-off heat is poor and "sticks" the function surfaces of the cutting tool, mainly the cutting face [3].

It is possible to machine the reinforced composites on the standard metal or alternatively wood processing machine tools without cooling, but with sucking dust and chips [3].

Very low carrying-off heat of the machined material (glass reinforced composite) causes that the heat is not getting through to the chip and the work piece so extensively as by the metal machining. Therefore it must be carried-off by tool. This significantly increases the tool wear. To use the cooling system is not possible, alternatively only in few rare cases [3].

It is possible to use cemented carbide with high quality coat or diamond (PCD).

As the composites are low resistant to temperatures (100 to 300 °C) they are not constant and so the cutting conditions need to be adjusted not to reach the critical temperature [3].

The physical properties of the fibre and the basic material are completely different and together with the fibre orientation predestinate the cutting power and machinability of composite material [3].

2. MEASUREMENT OF THE CUTTING TEMPERATURE

Considering the tool life and surface conditions of the work pieces, the investigation on the thermal phenomena of cutting processes is essential, moreover, it is a basic duty in the research work concerning the high speed and ultra-precision machining.

In spite of the fact that is this issue is known for about 80 years, there are some unanswered questions due to imperfect measuring methods [1].

According to Koening, the most reliable method for the measuring of the cutting temperature (Θ) is measuring by thermocouple into the cutting tool, and on the other hand, the thermocouple has to be calibrated for every tool work piece material (Fig. 1) [1,4].

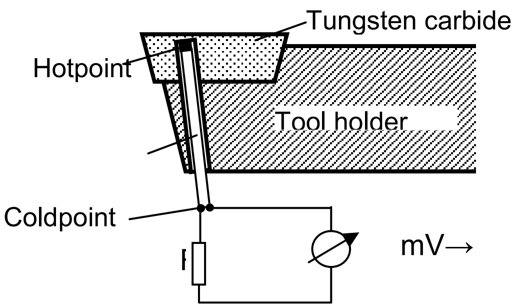

Fig. 1. Measurement of the cutting temperature by thermocouple [1, 3]

There are measuring methods using infrared temperature indication that detects the infrared radiation coming from tool-chip interface without direct contact. A thermo-map could be taken on any designed part of the cutting zone by the infrared camera and it is also possible for the data to be separately evaluated. In this case, the sophisticated camera must be positioned far from the cutting zone, otherwise the removed tool-chips may disturb the continuous sensing during cutting. Further disadvantage is that continuous data recording is possible with the camera. These disadvantages, however, can be eliminated by transmitting the infrared radiation in fibre-optics [1].

2.1. Cutting temperature measurement in the machining GFRP with the infrared camera

In Fig. 2, the positioning of the FLIR T360 infrared camera, the 2D thermo-map and the 3D thermo-map on designated part can be seen. The 3D thermo-map is taken by FLIR Quick Report 2.1 software.

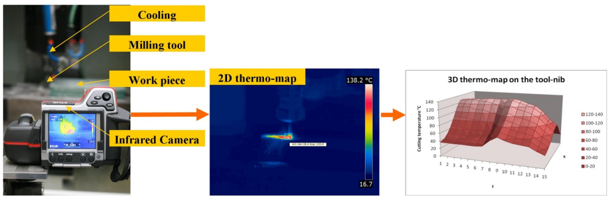

Fig. 2. Cutting temperature measuring system with infrared camera [4]

Experiments were provided at the Kecskemét College Faculty of Mechanical Engineering and Automation. The main aim of the experiments was to find out the temperature during the GFRP materials at machining with different cutting conditions (three-factorial experiments) with cold air cooling and MQL (Minimal Quantity Lubrication). During the experiments there were used two milling tools with diameter 6 mm. The cutting materials were: monolith sintered carbide cutting tool with coat TiSiN (*Pramet*) and diamond coat (*Seco*).

The cold air was made by the help of *Vortex tube* system. The cold air temperature was about -2°C. The liquid in the MQL cooling system was vaporized alcohol (with no. MY E 610).

Tomill 250 3D CNC Milling Center (Fig.3) was used. Cutting conditions are shown in Table 1.

Fig. 3. CNC milling centre Tomill 250 3D [4]

Experiments were based on factorial experiment. Fifteen measurements (at every tools and cooling system) with three different variables were performed: cutting speed (v_c), feed (f_z) and depth of cut (a_p). In Table 2 variation intervals and levels of experimental settings are presented, which were calculated for different constants.

The exponential equation can be shown:

$$\Theta = C_{\Theta} \cdot v_c^{x_1} \cdot f_z^{x_2} \cdot a_p^{x_3} \qquad (1)$$

C_{Θ} is unknown constant and x_1, x_2, x_3 are unknown exponents. After logarithmisation and transformation of (Eq.1) the following formula is:

$$y = b_0 + b_1 \cdot x_1 + b_2 \cdot x_2 + b_3 \cdot x_3 \qquad (2)$$

In this way, constants of the polynom can be easily determined. For the simplificating of matrix-calculation EXCEL table-operator software was used. The exponents and constants values are shown in table 2.

To get a better view, the results are shown in Fig.4. In the graph, on the axis X are variables (v_c, f_z, a_p), on the axis Y are cutting temperatures at various types of tool (Pramet and Seco) and types of cooling system (MQL and cold air cooling) of the experiments.

Table 1. Cutting conditions [4]

No	v_c [m/min]	f_z [mm]	a_p[mm]	a_e [mm]	z [-]	v_f [mm/min]
1	150	0,05	1,5	3	4	1592,4
2	250	0,05	1,5	3	4	2653,9
3	250	0,05	2,5	3	4	2653,9
4	150	0,05	2,5	3	4	1592,4
5	150	0,1	1,5	3	4	3184,7
6	250	0,1	1,5	3	4	5307,9
7	250	0,1	2,5	3	4	5307,9
8	150	0,1	2,5	3	4	3184,7
9	200	0,05	2	3	4	2123,1
10	250	0,075	2	3	4	3980,0
11	200	0,075	2,5	3	4	3184,7
12	150	0,075	2	3	4	2388,5
13	200	0,1	2	3	4	4246,3
14	200	0,075	1,5	3	4	3184,7
15	200	0,075	2	3	4	3184,7

Table 2. Values of constants and exponents

	Seco Vortex	Seco MQL	Pramet Vortex	Pramet MQL
C_Θ	11,49	31,233	14,71	65,289
x_1	0,435	0,28	0,21	0,136
x_2	0,122	0,068	-0,188	-0,034
x_3	0,419	0,368	0,658	0,072

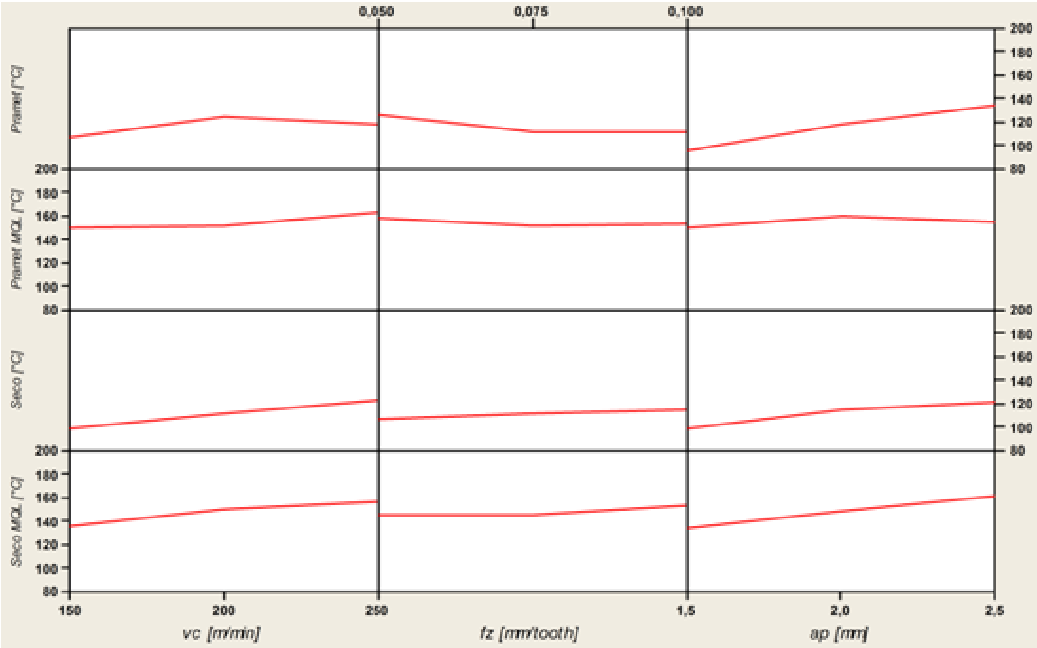

Fig. 4. Matrix plot results of the experiments

3. RESULTS

On the base of experiments was established, that with increasing of feed (f_z) cutting temperature decreases. It can explained with fact, that tool presses only the abrasive fiberglasses, at low feed. The tool doesn't machine the composite of extender and matrix, so the cutting temperature increases. It has negatively impact on the tool wear. Therefore is preferable to use higher feed at machining of glass-reinforced composite materials – between tested borders(f_z = 0,05 - 0,1 mm/teeth).

At using of Seco mill cutter tool the exponents were positive in f_z (Table 2). This is because the diamond coat is very good thermal conductive material.

The MQL cooling system was not good, because the cutting temperatures were much higher than cold air cooling at all cutting tools and cutting conditions. MQL cooling system is not recommended to use at machining of polymer composites (GFRP, CFRP).

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The surface layers mechanical strengthening

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Abstract

The paper is focused on analysis of surface layers mechanical strengthening effects on their properties and improvement of these especially at dynamically loaded parts and forming tools. The surface layer significantly influence fatigue resistance of dynamically stressed parts or tools. The paper mentions also results of some experiments which were focused on surface layers strengthening of chosen tool steels after heat treatment.

Keywords: Plastic deformation; Surface layer; Deformation strengthening; Shot peening; Residual stress.

1. INTRODUCTION

The wear strength, properties and lifetime of dynamically loaded parts and forming tools are significantly influenced by surface layer, which is affected by many factors influencing lifetime. So it ca be supposed, that strengthening (or improvement of the quality) of surface layer of given part, formed part or tool their lifetime and properties increase. There are many methods of strengthening or quality improvement of surface layer, but not all of them can be used for every types of parts and forming tools, because of economy or limitations of given process. The beneficial effects of surface layers mechanical strengthening for dynamically loaded parts used in automotive, aircraft industry and for special purposes, were establishment and proved in past. One of technological possibilities of cyclic loading (fatigue) resistance increasing of parts and tools is surface plastic deformation, resulting in surface layers strengthening. Paper mentions only some results of experiments obtained during determination of influence of some parameters on surface quality during surface layers strengthening of selected tool steels used for forging dies production.

2. METHODS OF SURFACE LAYERS MECHANICAL STRENGHTENING

The methods of surface layers mechanical strengthening can be divided to static methods and dynamic methods. The strengthening methods can be divided also to methods of dry strengthening and methods of wet strengthening. They can be also divided to:

- methods of strengthening by rigid strengthening tools,
- methods of strengthening by stream of strengthening bodies (particles).

The static methods surface layers strengthening include methods, where plastic deformation of surface is induced by pressure of strengthening tool without impacts.

The dynamic methods include methods, based on impacts of strengthening shots (steel balls, cast iron grit, glass beads, glass grit, etc.), or methods using energy of explosion, ultrasonic energy, etc.

The dynamic methods of surface layers strengthening are:

- shot peening (dynamic shot peening based on principle of blasting, pneumodynamic shot peening, glass balls are used),
- wet tumbling,
- ultrasonic peening,

- explosive strengthening.

Each of methods mentioned above has its specifical characteristics and specifical application areas [1, 2].

3. MECHANICAL STRENGHTENING OF SURFACE LAYERS AND ITS EFFECTS

The methods of surface layers mechanical strengthening (dynamic shot peening is one of them) cause:

- increasing of hardness, yield strength and ultimate tensile strength by deformation strengthening,
- densification of material due to closing of pores,
- creation of layered structure by plastic deformation of grains (Fig. 1),
- creation of own residual stresses due to compressive stress input into surface layers at strengthening,
- change of surface quality.

The typical curves of residual stresses created after machining especially after finishing operations machining and after dynamic shot peening in surface layers and layers deeper under surface are in Fig. 2 [1].

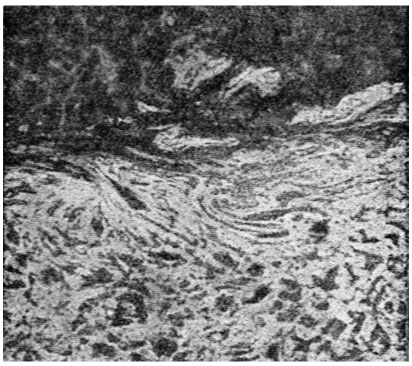

Fig. 1. Texture of surface layers after shot peening; Magnification 100x

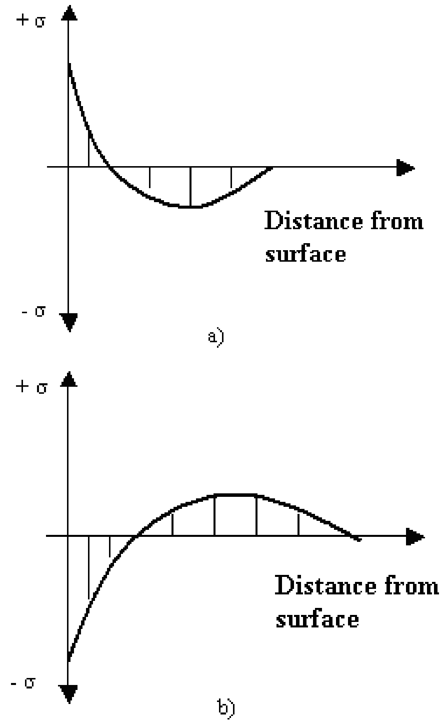

Fig. 2. Typical curve of residual stress; a – after finishing operations of machining, b – after shot peening

4. RESULTS OF EXPERIMENTAL TESTS FOR EVALUATION OF EFFECTS OF STRENGHTENING

Chemical composition of STN 419552 and STN 419721 tool steels used for experimental tests are mentioned in Tables 1 and 2. The test samples were hardened and tempered to required hardness and subsequently their surface layers were strengthened by dynamic shot peening. The parameters of equipment used for surface layers mechanical strengthening by dynamic shot peening are in Table 3.

Table 1. Chemical composition of STN 419552 steel

C [%]	Mn [%]	Si [%]	Cr [%]	Mo [%]	V [%]	P [%]	S [%]
0,32 to 0,42	0,20 to 0,50	0,80 to 1,20	4,50 to 5,50	1,10 to 1,60	0,35 to 0,60	max 0,030	max 0,03 0

Table 2. Chemical composition of STN 419721 steel

C [%]	Mn [%]	Si [%]	Cr [%]	W [%]	V [%]	P [%]	S [%]
0,25 to 0,35	0,20 to 0,50	0,15 to 0,45	2,10 to 2,60	8,50 to 10,0	0,15 to 0,30	max 0,030	max 0,03 0

Table 3. Parameters of equipment used for surface layer strengthening by dynamical shot peening

Diameter of blast wheel [mm]	330
Rotations of blast wheel [min^{-1}]	1900
Diameter of strengthening bodies (balls from patented wire) [mm]	1,0 to 1,5
Amount of balls shot on strengthening surface [$kg.min^{-1}$]	85±10
Minimal weight of balls amount in magazine [kg]	300
Electric engine power [kW]	5,5
Width and length of strengthened area (distance 470 mm from blades of blast wheel) [mm]	75 x 500

The dependence of surface roughness before and after shot peening (8 min) from hardness of sample (19552 steel) before shot peening is in Fig. 3.

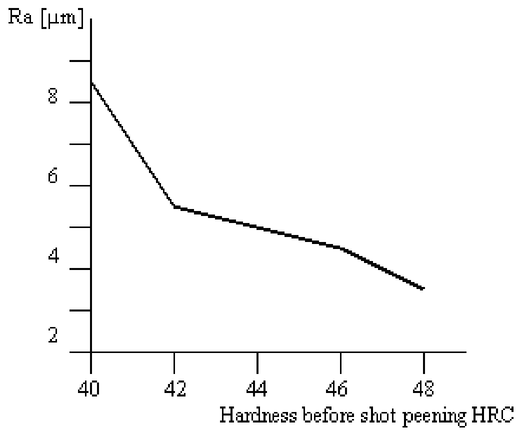

Fig. 3. The influence of initial hardness on surface roughness after shot peening (19552 steel shot peened 8 min, surface roughness before shot peening Ra = 0,44 up to 0,47 μm)

The measured surface roughness values before and after shot peening (8 min, 19721 steel) are in Table 4.

Table 4. Measured values of surface roughness before and after shot peening (shot peened 8 min) for STN 419721 steel

Parameter	Sample number					
	1	2	3	4	5	6
Mean value of hardness before shot peening HRA	70	70	75	75	75	74
Mean value of hardness after shot peening HRA	73	74	78	77	77	77
Mean value of roughness before shot peening Ra [μm]	0,27	0,24	0,37	0,35	0,22	0,38
Roughness after shot peening Ra [μm]	2,82	2,46	1,67	2,33	2,97	3,30
	2,99	2,82	1,61	2,37	2,63	2,07
	2,41	2,93	1,96	2,62	2,77	2,84
Mean value of roughness after shot peening Ra [μm]	2,74	2,74	1,75	2,44	2,79	2,74

The surface roughness profile for sample (Table 4) before shot peening is in Fig. 4 and after shot peening in Fig. 5. The surface roughness was measured by Surtronic 3 (manufacturer Rank Taylor-Hobson) at length of measurement 4 mm [3, 4].

Other samples have also similar character of roughness before and after shot peening. Even if the surface roughness after shot peening is increased, the character of roughness profile and so notch effect changes significantly. The changes of the character of surface roughness profile can also slightly affect the friction with using of lubricant.

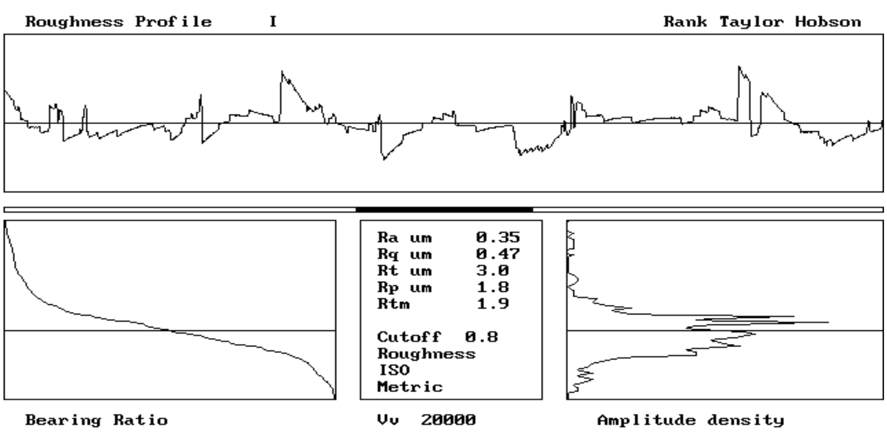

Fig. 4. Surface roughness profile of sample 4 (Table 4) before shot peening

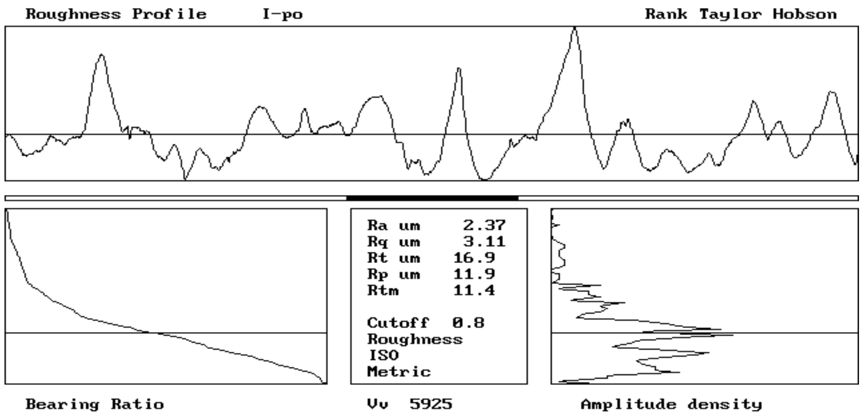

Fig. 5. Surface roughness profile of sample 4 (Table 4) after shot peening

The measured microhardness values after dynamic shot peening of 19552 steel on various distances from surface for test samples with initial hardness 40 HRC and 48 HRC are in Table 5.

Table 5. Measured microhardness values influenced by distance from surface for 19552 steel shot peened 8 min

Hardness of sample before shot peening	Distance of indention from surface [mm]	Measure-ment No.1	Measure-ment No.2	Mean value of hardness HV
		Hardness HV	Hardness HV	
40 HRC	0,04	478	478	478
	0,06	478	464	471
	0,15	444	396	420
	0,24	409	422	415
	0,36	411	394	402
	0,45	398	398	398
	0,55	404	394	399
48 HRC	0,04	530	540	535
	0,08	527	511	519
	0,14	499	527	513
	0,23	508	496	502
	0,32	502	493	498
	0,44	476	511	494

5. CONCLUSION

The method of surface layers mechanical strengthening by dynamic shot peening is relatively universal method based on surface plastic deformation. It can be applied after or before heat treatment or for parts without heat treatment. The character of roughness profile after shot peening changes significantly compared to surface after grinding. The shot peening time about 6 min can be considered as a critical at strengthening of surface layer after heat treatment (hardening and tempering) of STN 419552, STN 419721 tool steels, because the roughness of surface reaches its maximum value. So the shot peening time of these heats treated steels should be longer from 8 to 10 min. The microhardness measurements at various distances from surface proved satisfactory hardness distribution, which enables properties enhancement after application of surface layers mechanical strengthening. The depth of strengthening at given parameters achieves from 0,4 to 0,5 mm depending on initial hardness of test samples. The experiments include also other measurements, but these are not mentioned here because of limited number of pages of this paper.

6. ACKNOWLEDGEMENTS

Authors wish to thank for APVV 0057-07 grant financial support.

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A comprehensive investigation of copper pipes joints made of resistance soldering

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Abstract

The soldering of copper pipes by electric resistance is an alternative to conventional heating by flame. Copper pipes are used in many areas of building services. The aim of this work is to evaluate the changes in the quality and properties of the soldered joints caused by heating changes. Manipulability with the resistance soldering tool is worse than the manipulability with torch which may result in an increase of defects. The heating is not as regular as the flame soldering, which increases the risk of cavities in the capillary gap. The microstructural analysis shows that the average thickness of the IMC on the samples which were made by flame soldering is less than the thickness of the IMC on samples which were made by resistance soldering. The advantages of this way of heating increased safety, effectiveness and it is more environmentally friendly. The defects which were observed did not limit using the electric resistance heating of copper pipes in industry.

Keywords: Soldering; Copper pipes; Resistance heating.

1. INTRODUCTION

The present work deals with comparing the quality of solder joints formed by flame heating and electrical resistance heating. The soft capillary soldering of copper pipes and brass fittings is the most commonly used technology for the making of water systems in the building, food and chemical industries.

Electrical resistance soldering of Cu pipes is one of the alternatives to conventional heating by flame. Even these new methods of soldering use physical principles such as wetting and capillary of the solder. Using new methods of heating has increased fire safety, reduced the financial demands of installation and increased workflow speed [1].

The research objectives are to compare the material, technological and practical advantages of conventional heat pipe lap solder joints formed by the two technologies under the same conditions.

2. METHODS AND MATERIALS USED FOR RESEARCH

The experiment used soft solder in paste form with a liquidus temperature up to 450 °C. The solder paste, containing flux (40%) and solder powder (60%), was added to the solder, in the form of wire of the same composition. Specifications of solder pastes and solders are listed in Table 1. Semi-thin copper tube, manufactured according to STN EN 1057, has been designated as Supersan Ø 18 x 1 mm.

Preparation before soldering

1st: vertically cut of Cu pipe;

2nd: treatment and control of external and internal diameter;

3rd: clean solder surfaces of pipes and fittings;

4th: deposition of solder paste on the pipe surface.

Table 1. Specifications of solder pastes and solders [7, 8]

Commercial name	Producer	Composition	wt. [%]	Melting range [°C]
Paste Degufit 4000	BrazeTec	Sn3Ag	96,7 Sn	221-230
BrazeTec 4			3,3 Ag	
Paste Cu 3	Rems	Sn3Cu	97 Sn	230-250
Lot Cu3			3 Cu	

2.1. Process of soldering

Soldering with a flame is similar to gas welding. The place of the joint is heated by the energy from combustion of flammable gas with air or oxygen. the tubes around the joint are heated until the solder is liquid and the solder fills the capillary gap. Heating makes the flame torch at a distance of 40-60 mm from the joint. Parameters of the flame soldering method are defined in Table 2. The brazing flame used different mixtures of gases; for example: acetylene and oxygen, hydrogen and oxygen, propane and air, and MAPP and air [2].

The soldering temperatures for different combustible gases mixed with oxygen are shown in Table 3.

Table 2. Parameters of flame soldering

Type of torch	Bernzomatic T 757 P
Thermal load	3,4 [kW]
Combustible gase	MAPP
Soldering time	31 [s]

Table 3. The burning temperature for different combustible gases [9]

Gas	Acetylen	MAPP	Propan	H_2
[°C]	3200	3090	2850	2100

Soldering by electrical resistance is determined for the joining of copper pipes with a diameter of 6-54 mm. In practice, two methods of heating are used. The first is heating by metal electrodes (low electrical resistance), where heat is generated directly in the bonded materials. It is often used to solder materials with a high electrical resistance, such as steel. Another option is to use carbon electrodes that have a high electrical resistance and therefore can be heated very quickly and strongly. For pipes with a large diameter, they can reach temperatures of up to 900 °C [3]. The incurred heat is distribution by the heat conduction. A few seconds later, the tube is heated to soldering temperature and the internal tube is heated too, by heat conduction. It is used for soldering conductive materials such as copper.

To ensure a good transfer of heat, the soldered parts must be adapted to the shape of the electrodes. They should have the biggest contact area with soldering material. The small contact surface on the relative bigger components is the cause of overheating the soldered surface. Prismatic shaped electrodes are suitable [4].

Table 4. Parameters of resistance soldering

Equipment	Rems Contact 2000
Nominal current	8,7 [A]
Secondary current	250 [A]
Soldering time	12 [s]

2.2. The proceeding for quality evaluation of joint

Immediately after the soldering, the visual inspection of the soldered joints was carried out. Leaking of the solder, filling of the capillary gap, the presence of flux residues, and solder overflow and were rated. Subsequently, macroscopic analysis was performed. The macroscopic analysis was made on the light microscope at an objective magnification of 25x. Errors in the joints were observed such as porosity, cavities and inclusions. In accordance with the objectives of this research, intermetallic phases (IMC) were analysed by light microscopy (400x magnification) on the interface of solder joints.

3. RESULTS

The analysed samples accounted for a uniform capillary leaking of the solder and sufficient filling of the capillary space. Only local errors such as cavities in capillary gap and excessive leaking of solder from inside the joint were observed. Based on the visual inspection, there was no visible difference between the quality of the samples of soldering by flame and electrical resistance.

Macroscopic analysis provides proof that cavities frequently occur in the capillary gaps. Flame soldering accounted for less cavities than the resistance soldering. The local transfer of heat energy from the graphite electrodes on the outside of the pipe joint was achieved by the resistance heating. Heating of the inner tube is realised only by the mechanism of heat conduction.

Each of the analysed samples indicates formation of intermetallic phases with an average thickness ranging from 1.6 μm to 4.5 μm. The average thickness of intermetallic phases in samples is shown in Figure 1.

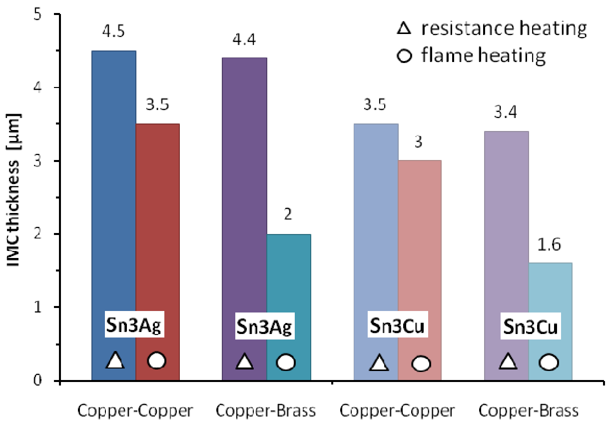

Fig. 1. Average thickness of IMC

Figure 2 shows the microstructure of Cu-Cu bond of a Sn3Cu solder created by resistive heating. Microscopic analysis showed the formation of a uniform layer of two intermetallic phases, Cu_6Sn_5 and Cu_3Sn. At the interface is located a thin non-wetting phase Cu_3Sn, which is followed by a phase of Cu_6Sn_5. On the interface of the Sn3Ag solder, the same phase boundary is created. A similar formation of transition phases was observed of works [5, 6].

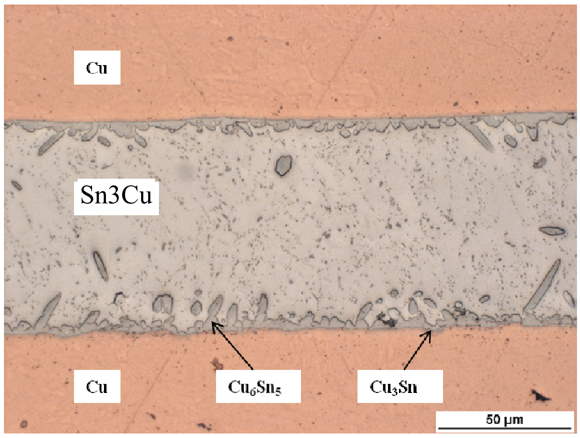

Fig. 2. Microstructure of boundary Cu-Sn3Cu-Cu, resistance heating (400x)

In Figure 3 a microstructure of the Cu-brass bond is shown, made from flame soldering by an Sn3Ag solder. Pictured is the same area of intermetallic phases, Cu_6Sn_5 and Cu_3Sn, as in the resistance soldering. This area is thinner and less rugged.

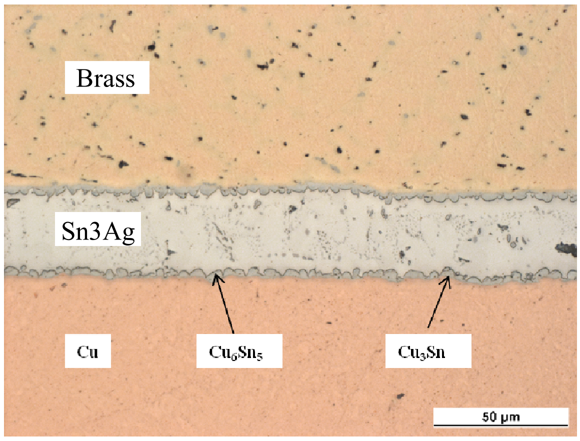

Fig. 3. Microstructure of boundary Cu-Sn3Ag-Brass, flame heating (400x)

The analysis of the heat transfer by the thermal imager showed that resistance soldering is approximately three times faster than flame soldering. The heating rate is influenced by: the diameter, the thickness and thermal conductivity of pipes, concurrently by the shape and distance of electrodes from of the soldering place. The difference in the temperatures reached, depending on the distance from the soldering point to the electrodes, is shown in Figure 4. When we displaced the electrodes on the brass fitting by about 10 mm, (during the same time 12s) the final temperature was about 130°C less.

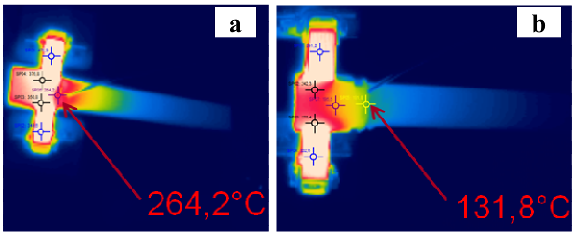

Fig. 4. Temperature in soldering place after 12 second heating
a) electrodes near soldering place
b) electrodes distant from soldering place

4. CONCLUSIONS

The analysis approved the high efficiency, economy and quality of solder joints formed by resistance soldering. The heating rate of solder joints was, on average, three times higher than the heating by flame. It has been proved that the solder filled the capillary gap of the lap solder joints as well as the flame heating. Created joints have the required quality, strength and tightness for using in the pipelines.

Based on the results of metallographic analysis, we suppose dissolving the surfaces of the copper pipes in the tin matrix of solders and creating stable diffuse joints for both solders (Sn3Ag, Sn3Cu). For all samples, the zone of the solubility of copper in the solder tin matrix of solders comprising phases Cu_3Sn and Cu_6Sn_5 was created on the phase boundary. The first raised the Cu_3Sn phase. Subsequently, depending on Cu the concentration raised the phase Cu_6Sn_5. The microstructural analysis showed that the average thickness of the IMC on samples made of flame heating is less than the average thickness of the IMC on samples soldered with electric resistance.

In terms of safety, resistance soldering is safer, because it doesn't use an open flame. It can be used for the soldering of pipes in places with a higher fire risk, for example with combustible materials. The disadvantage of resistance soldering compared to the flame heat is that it has worse access to places and unstable heating of the soldering joints.

5. ACKNOWLEDGEMENTS

The contribution was prepared under the support of VEGA project - 1/0211/11 Development of lead solder for higher application temperatures and research of material solderability of metallic and ceramic materials.

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A new approach to assembly systems

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Abstract

The paper deals with issues of assembly systems. It will introduce a classification according the size of the product and its serial. The aim of the article is to assist to assembly systems designers in choosing the optimal assembly system for the size of the product and for the annual production volume. Special emphasis is given on humanization of the assembly.

Key words: Assembly; Assembly systems; Humanization; Layout.

1. INTRODUCTION

An assembly is a discontinuous process. In discontinuous process mainly in assembly has been created a huge quantity possible organizational-technological arrangement called layout. Often we see for the character of assembly is not use the optimal assembly system. **The optimal system is a system which has the shortest term return on investment (economic view). But it is also a system which has the highest possible degree of humanization of human work acceptable for operators of the third millennium.** For operators of the third millennium does not satisfy low level of operations carried work in forced tact of the assembly line without mechanization and motorization of operations standing or while walking as it was in Taylor's assembly lines at the beginning of the 20th century. Unfortunately, this assembly line still exists and are imported in large numbers also in Slovakia from countries of their origin where they are not already eligible.

The aim of the article is to assist to assembly systems designers to design the system with short payback period and system with high degree of humanization.

Described knowledge are useful mainly in assembly. It can be used also in other discontinuous production processes.

2. PRODUCT SIZE AND ITS SERIAL

General true that the smaller the product is the higher is the annual production. The small things do medium things.
Joining several medium products is creating large products. The smaller products are and their structure is simpler is more efficient mechanization and automation assembly. From that point of view, products can be divided into:

- **Fine products** (examples: ball pen, battery cell, bullet to the gun)

These products can be assemble that simultaneously assemble the entire product lot in one fixture. The machine simultaneously assembles the entire lot. The operator grip once a tool and make it sequentially the operation sequentially in all products. Similarly, the machine after components insertion to the multi component fixture connects all components at once. Another way to achieve high performance is the automation of the rotor or jet assembly lines (Fig. 3).

- **Small products**

These are products which can be handled manually. (kitchen blender, radio, cell phone). These products are assembled "piece by piece.". After assembly it can be stored to the range which includes a small dose of products.

- **Middle heavy products**

These are products that need to be handling with mechanization. Examples: refrigerator, bicycle, etc.

- **Heavy products**

Heavy products are usually assembled on a carriage rail-grippers. Some trucks have a positioner of the product that the product may not be installed from below. Examples: motorcycle, car and others.

- **Extremely heavy products**

The product is assembled in one place which gradually are brought the assembly subgroups.

3. ASSEMBLY SYSTEMS CLASSIFICATION

In the figures 1 to 4, so in the chapters 3.1 to 3.4 are located known assembly systems with description their basic functions.

3.1. One operating stations

Used there where assembly operation requires one big machine to execution one operation (e.g. pressing on the large press). Known layout these stations is in the fig. 1.

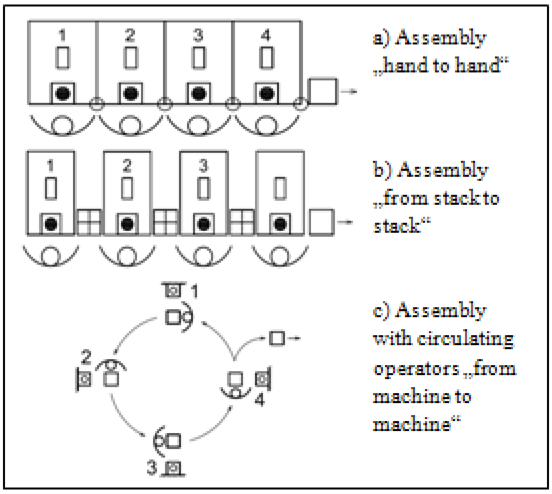

Fig. 1. One operating station

3.2. Assembly nests

Human or robot assembly whole product or dose tiny respectively small products (Fig.2).

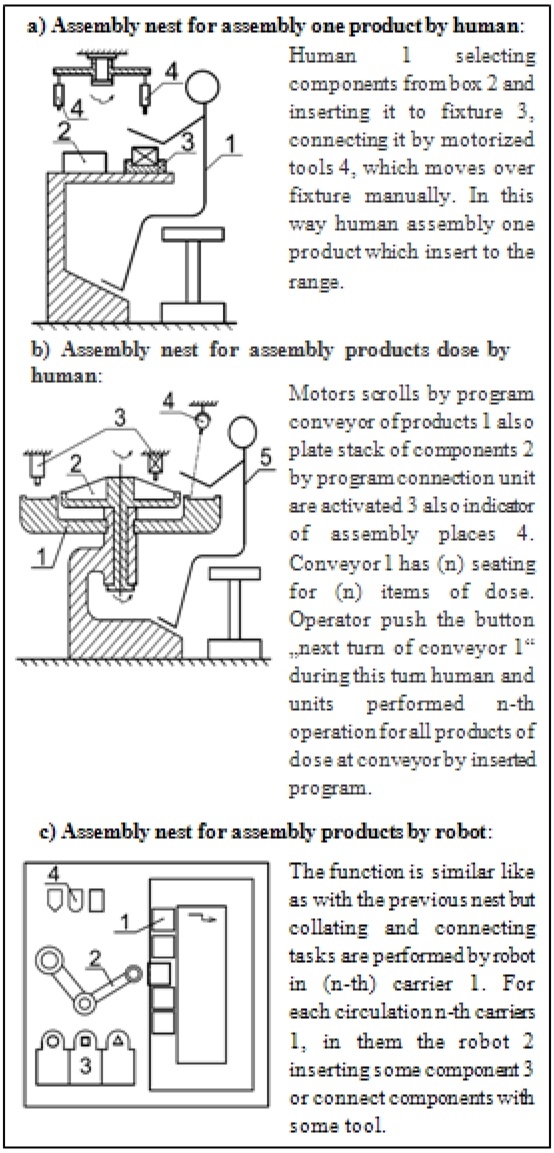

Fig. 2. Assembly nests

3.3. Assembly lines

The typical characteristic of assembly lines is the assembly conveyor where products carriers are moving by hand, gravity or motorized (Fig. 3). The synchronous and asynchronous lines are usable for Middle heavy products and heavy products. The rotor lines and jet lines are usable for tiny products which are mass produced, especially when the times of operations are different.

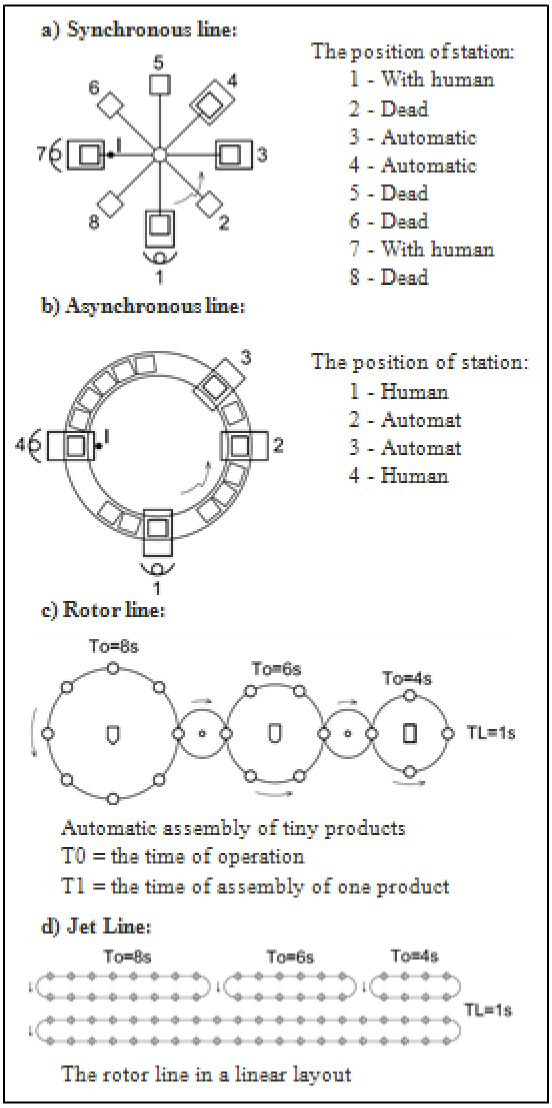

Fig. 3. Assembly lines

3.4. External assembly of extremely large products

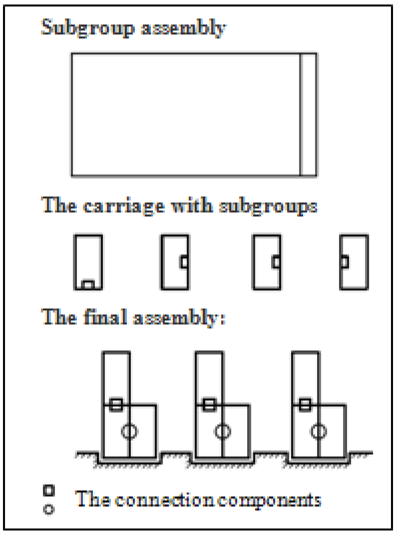

Fig. 4 Assembly of extremely large products (e.g. plane)

It is assembly of crane turbine etc. directly at customer at home or abroad. At home factory only the subgroups are assembled. At the assembly place with subgroups are manipulating with carriages, cranes and with similar tools. (Fig. 4).

4. SUITABLE SYSTEM SELECTION

The automatization of tiny products is possible at systems by Fig. 3c and Fig. 3d.

The advantage of these systems is the time loss does not exists not even if the times of operations are markedly different. These are systems with the highest performance but with the highest number of tools. The disadvantage is the insertion and removal of components during movement of the conveyor.

Also assembly nests by Fig. 2 allow for assembly in which the duration of operations differs significantly. At synchronous and asynchronous line, where the time imbalance of operation at stations leads to a rapid decrease performance of line, because performance assembly line determines the longest-running operation. The situation is similar for array of one operational workstations (Fig. 1). The highest degree of humanization of work has assembly nests by Fig. 2a,b. Workers has the same work freedom like e.g. all administrative workers. The nests have components stacks for whole shift. The worker has only one role and it is „turn out containers of components“. Content of the work is rich. The big advantage is the possibility to involve workers in the quality of their installation with personal responsibility for the assembled product. Unlike people work on lines has a very low level of humanization. This disadvantage is eliminated by one line with short elementary operations by several lines where one station to carry out the largest number of operations. It allows better assembly line time balance. Increase the volume of the work on the station and give to the station more than one person (group assembly). Until recently several authors had opinion asynchronous lines are more powerful than synchronous. (3)

Valentovič a Václav improved that in both systems is the same performance per hour even in cases where the problem occurred at stations. In some situations people can on asynchronous lines increased work effort to create conditions for a short break emptying stocks from station and filling the space behind the station. The disadvantage of asynchronous lines is their length, high prices of carrier, slow start and outlet of production. Large among operation stocks are „dead capital“. From this views is synchronous assembly line where next cycle starts up after work the slowest station more advantageous than asynchronous assembly line. It is well when the steps of carrier in the synchronous line are minimal, ie if the stations are located densely side by side. If the stations are large we put between it the dead stations. (Fig. 3).

5. CONCLUSION

For these reasons that don’t exists any formula which can find the optimal system for assembly. It can be only advise based on experience recommend assembly systems or don‘t recommend some systems. It's also because some companies prefer a shorter payback period of investment before more expensive solutions but with a high level of humanization. As an example may serve synchronous lines with continuous motion of carriers linked by chain. Workers walk when working along with carrier after operation must then be quickly returned to the starting position by body or just their hands (if sitting when working).

To Slovakia was imported assembly line, which forced the worker to insert one candy to the moving boxes every 1,5 second. Another example is cable harnesses assembly which is realized during the movement of carriers when worker walking or bending. Is improved investment in the humanization of work are good investment. Higher workers productivity is reached and quality of assembly is increased also commitment of workers to the company.

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A proposal for a system for determining the characteristics of the modeled surfaces

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Abstract

In this paper is described a methodology for determining the characteristics of the modeled surfaces in CAD systems. These characteristics has a major meaning in the development of process planning. These main characteristics can include surface dimensions, surface orientation and its type. The main role in determining the characteristics of areas is to design a system for storing the CAD data, which describe the surface. As input CAD data will serve file system format STEP AP 214As tool for CAD data processing will serve programming language C# 2008 using object oriented programming principles. For storing a CAD data will be used related database management system MySQL 5.3.

Keywords: CAD DATA; Surface; Database system.

1. INTRODUCTION

Process planning translates design information into the process steps and instructions to efficiently and effectively manufacture products. As the design process is supported by many computer-aided tools, computer-aided process planning (CAPP) has evolved to simplify and improve process planning and achieve more effective use of manufacturing resources. Manual process planning is based on a manufacturing engineer's experience and knowledge of production facilities, equipment, their capabilities, processes, and tooling. Process planning is very time-consuming and the results vary based on the person doing the planning. [1]

Integration of CA systems isn´t just that systems can communicate together, they must „understand" together too, that is they must share date that often are saving in different types of models with different information's format. [2]

There are a number of modelling methods designers can choose from including interpolating splines (cubic splines); basis-spline (B-spline) of which there can be rational B-splines and non uniform rational B-spline (NURBS); and Bezier mathematics. [3]

CAD software packages use two basic methods for the creation of surfaces. The first begins with construction curves (splines) from which the 3D surface is then swept (section along guide rail) or meshed (lofted) through. The second method is direct creation of the surface poles/control points.

From these initially created surfaces, other surfaces are constructed using either derived methods such as offset or angled extensions from surfaces or via bridgings and blending between groups of surfaces. [4]

There are many advantages to an mathematical form. Much of this material was developed for CAD applications and fields like ship design where explicit shapes are an integral part of the design process. [5]

2. PROCESSING OF CAD DATA

CAD data processing takes place in stages. The aim being to obtain the necessary data and relations, which are located between the entities.

All data are stored in a relational database system, which ensures the integrity of the original data and work with the information thus obtained is simpler and more flexible with regard to use SQL (Structured Query Language).

File which is inserted into the system is not altered in any way. Given that as such data would be difficult searched and processed. A new file which stores only data that is the section in the DATA STEP file. The next phase is to find the rows that contain keywords and subsequent separation and collection of values that are in this line. As an example situation in Fig. 1. *Cartesian_point* method accepts one required input parameter and the text line which is located in the definition of a point in space. The return value of this method is an array with size of 3 elements which are stored coordinates of the point. This example are also obvious that to obtain necessary data from the row, which is located definition DIRECTION method can be used resulting overload methods cartesian_point. Likewise they are adjusted each row which are keywords. Thus prepared data can be inserted into the database system. Given that data which were inserted without defined session. It is necessary to create a relational table which describes relationships between entities.

```
public string[] cartesian_point(string input_text)
{
    char trimchar = '#';
    string temp_value;

    temp_value = input_text.Replace("));", "");
    temp_value = temp_value.Replace("(","");
    temp_value = temp_value.Trim(trimchar);
    string[] array = new string[4];
    array = temp_value.Split(',');
    string[] cartesian_point = new string[3];
    for(int i = 0;i<=2;i++)
    {
        cartesian_point[i] = array[i+1];
    }
    return cartesian_point;
}
```

Fig. 1. Example of separation and subsequent acquisition values

As the relational database management system (RDBMS) has been used database system called MySQL in version 5.3 . Data of the surfaces could be stored in standard text file, but use the RDBMS causes more simplicity and more efficiency. In the text file system arise the following problems:

a) Opacity of the inserted data

b) Slower data processing

c) Susceptibility to loss of data integrity

d) Large loading of the system

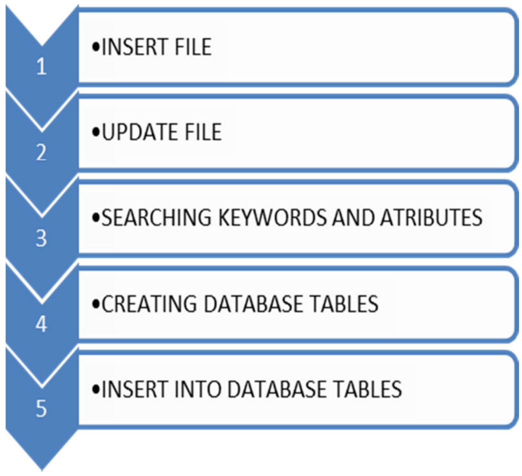

Fig. 2. Processing of CAD data

As the programming language has been used C# 2008. This language has many tools for communication with relation database management systems. In the data processing but also in determining the properties of surfaces are used principles of object oriented programming (OOP) . This method brings greater simplicity and it allows expandability of the application. In this case the principles of OOP are mainly used for computing the normal vector in any point of the surface.

2.1. Surface definition in STEP 214

As an example to show, how is surface defined in STEP 214 may serve a B-spline surface. Table 1. shows all parameters and its type which describing B-spline surface.

Table 1. Surface definition in STEP 214

Atribute	Type
name	STRING
u_degree	INTEGER
v_degree	INTEGER
control_points_list	ENTITY
surface_form	ENUM
u_closed	LOGICAL
v_closed	LOGICAL
self_intersect	LOGICAL
u_multiplicies	LIST OF INTEGER
v_multiplicies	LIST OF INTEGER
u_knots	LIST OF parameter_value (REAL)
v_knots	LIST OF parameter_value (REAL)
knot_spec	knot_type (ENUM)

All of these parameters are important to describe the surface.

3. DETERMINING THE PROPERTIES OF B-SPLINE SURFACE

In STEP 214 the B-spline surface can be defined as it shows fig. 3. In a similar manner is defined Bézier surface or NURBS surface.

The first line defines the type of surface, numerical values in brackets in the first line define degree of curve which surface consists of (in this case 3,3). The second to fifth line defines network of the control points that describe surface. Seventh and eighth row defines the number of nodal values vector for the curve. In the ninth and tenth row absolute values are expressed.

Due to the way it is defined by B-spline surfaces should be used method of deposit where the relationship between the values will be maintained.

```
#104 = B_SPLINE_SURFACE_WITH_KNOTS ( 'NONE', 3, 3, (
 ( #91, #58, #30, #48, #85, #76, #56, #90 ),
 ( #44, #67, #49, #38, #53, #77, #95, #41 ),
 ( #88, #51, #78, #86, #50, #75, #98, #42 ),
 ( #80, #54, #82, #81, #94, #59, #93, #99 ) ),
 .UNSPECIFIED., .F., .F., .F.,
 ( 4, 4 ),
 ( 4, 1, 1, 1, 1, 4 ),
 ( 0.0000, 1.0000),
 ( 0.0000, 0.1866, 0.3733, 0.5600, 0.7800, 1.0000 ),
 .UNSPECIFIED. ) ;
```

Fig. 3. B-spline surface definition in STEP 214

The definition of B-spline surface in STEP 214 not always has the same structure. It depends on the number of control points and values of nodal vectors. Before we determine the properties of surface we need to know the structure of data. One possible way is to count the number of rows and find what type of information is stored in row.

In determining of the properties of B-spline surface is the most important task find values of the basis functions. The basis function is defined by (1) and (2).

$$N_i^k(t) = \frac{t-t_i}{t_{i+k}-t_i} N_i^{k-1}(t) + \frac{t_{i+k+1}-t}{t_{i+k+1}-t_{i+1}} N_{i+1}^{k-1} \quad (1)$$

$$N_{i,1}(u) = \begin{cases} 1 \text{ If } t_i \le u \le t_{i+1} \\ 0 \text{ Otherwise} \end{cases} \quad (2)$$

To compute the basis functions is used class called *b_spline* which define the method called *basis_function*. The basis functions are compute through cycles which are controlled by data from input STEP file. In this case can be seen the advantages of object oriented programming because formula to compute derivate of basis function is similar like formula to compute basis function and we can use principle of heredity.

3.1. Computation the surface parameters

Important information for each surface are the coordinates of normal vector in any point of the surface. B-spline normal vector is defined by (3).

$$\vec{N} = \frac{dP}{du} \times \frac{dP}{dv} \quad (3)$$

Where $\frac{dP}{du}$ and $\frac{dP}{dv}$ are the tangents. The tangents are defined by (4) and (5).

$$\frac{dP}{du} = \sum_{i=1}^{N}\sum_{j=1}^{M} P_{i,j} N_{j,i}(v) \frac{dN_{i,k}(u)}{du} \quad (4)$$

$$\frac{dP}{dv} = \sum_{i=1}^{N}\sum_{j=1}^{M} P_{i,j} N_{i,k}(u) \frac{dN_{i,j}(v)}{dv} \quad (5)$$

Another important information is information about points which are located in the surface. This point is defined by (6).

$$P(u) = \sum_{i=0}^{N}\sum_{j=0}^{M} P_{i,j}\, N_{i,k}(u) N_{j,i}(v) \quad (6)$$

In the Fig. 4 we can see the principle for calculating surface properties. Parameters $t_{u,I}$, $t_{v,I}$, P(u) and P(v) are obtained directly from the CAD data. $N_{i,k}$ and $N_{i,j}$ are the methods for computation surface basis functions. Next method is method for computation derivative of basis functions and the last method is used for tangent computation.

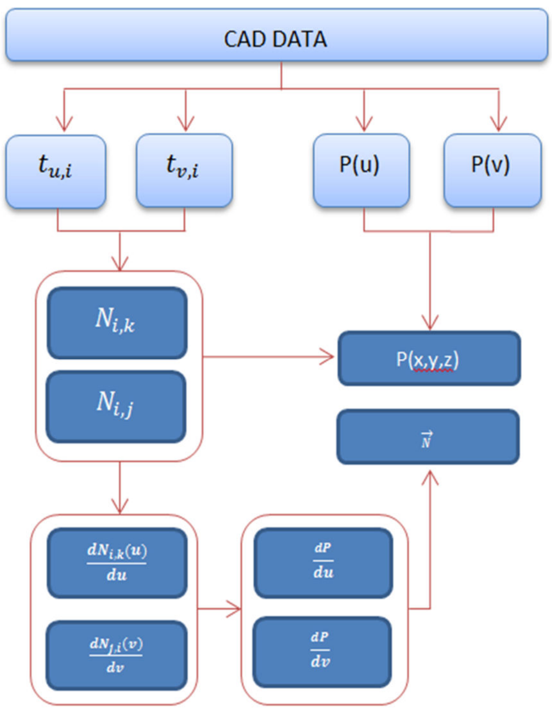

Fig. 4. The principle for calculating the properties of surfaces

Using these three methods, we can calculate the normal vector. These methods must be called in the correct order. To calculate point coordinates we have to call only one method to compute the basis functions. Using this set of methods all properties of the surface are known. All methods are defined in class called *b_spline*. For Bézier surface or NURBS surface can be used similar set of methods however formulas to computation surface properties will has to be modified.

4. CONCLUSION

In this paper is described system for determining the characteristics of the modeled surfaces in CAD systems. Information about surfaces are very important for CAPP systems. This solution also has the application in features extraction from CAD data. With features extraction the entire model can be described. In the data processing but also in determining the properties of surfaces are used principles of object oriented programming. Advantage of this system is an independence of the CAD systems, because it uses neutral format of data. This system can be included to the CAD systems like SolidWorks or Autocad because these systems has sophisticated application programing interface (API).

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Wettability of high-temperature brazing alloys on SiC-based ceramics

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Abstract

Contribution deals with the wettability study of high-temperature Ni-based brazing alloys (NI 102, NI 105 and NI 107) on SiC-based ceramics (RBSiC – reaction bonded silicon carbide). The measurements were performed in vacuum. Wetting kinetics was determined. The brazing alloys type NI 105 and NI 107 have wetted the surface of RBSiC ceramics. Very good wettabilty (20° < α < 40°) was achieved with brazing alloy NI 105. EDX analysis was also performed on wettability specimens. It was found out that Ni and Cr from brazing alloy intensively infiltrated into ceramics and rapidly reacted with free Si confined between α-SiC. Further tensions were carried in parent material and cracks arise near joints by cooling.

Keywords: RBSiC; High temperature Ni-based brazing alloys; High temperature brazing; Wetting; EDX.

1. INTRODUCTION

The SiC-based ceramics is characterised for example with a high wear resistance, high thermal conductivity, low thermal expansion and many other interesting properties. Owing to its unique properties, this material is finding a wide range of applications in almost all industrial branches. There are several technologies for joining SiC-based ceramics. However, joining of the most modern, pores-free, SiC-based ceramics, as RBSiC, does not allow producing the joints of desired properties. Instead of diffusion joining high-temperature brazing is very promising technology. Therefore the aim of this work was to study the material brazeability of a progressive SiC-based ceramics by use of high-temperature brazing alloys and to propose theoretical basis for improving the brazeability. Based on previous studies Ni-based high-temperature brazing alloys were chosen as reference material. These brazing alloys are the most common at high-temperature brazing of stainless steels but they were never use for brazing ceramics. However, Ni and Cr are frequently use at joining another types of SiC-based ceramics.

2. METHODS AND MATERIALS USED FOR RESEARCH

Experimental ceramics type RBSiC (reaction bonded silicon carbide) was selected from CeramTec GmbH Company. Its firm designation is Rocar® SiF. Basic properties of this ceramics are given in Table 1. Material was supplied in form of solid discs with diameter of 15 mm and 3 mm height. Its roughness was Ra 3.2.

Table 1. Properties of RBSiC ceramics (Rocar® SiF)

Density $[g.cm^{-3}]$	**Bend strength K_{IC}** $[Mpa.m^{½}]$	**Hardness** [HV]	**Thermal conductivity** $[m^{-1}K^{-1}]$	**Thermal expansion coefficient** $[10^{-6}.K^{-1}]$
3.07	4.0	1200 (Si) 2700 (SiC)	120 (20-100 °C)	4.9 (20-1000 °C)

3 high-temperature Ni-based brazing alloys in paste form were selected for experiments. By EN 1044 standard these pastes are designated as NI 102, NI 105 a NI 107. NI 102 (Cr-7%wt. Fe-3%wt. Si-4.5%wt. B-3.1%wt. P-0.02%wt. C-0.06%wt. -Ni) with optimum brazing temperature 1050 °C. NI 105 (Cr-19%wt. Si-10.1%wt. B-0.03%wt. P-0.02%wt. C-0.06%wt. -

Ni) with optimum brazing temperature 1190 °C. NI 107 (Cr-14%wt. Fe-0.2%wt. Si-0.1%wt. B-0.01%wt. P-10.1%wt. C-0.06%wt. -Ni) with optimum brazing temperature 980 °C.

All specimens were fabricated in vacuum of 10-4 Torr. Brazing temperature was in all cases identical with temperature given by the manufacturer as optimum brazing temperature applicable for steels. The wetting angle α was recorded directly during heating by use of experimental equipment from SAV Bratislava – Fig. 1.

The fabricated specimens were embedded into Varidur, to prevent their damage and then were cut by use of a diamond cutting wheel Buehler® Series 20 HC on equipment Buehler®

Isomet 5000. After cutting all specimens were again embedded. Grinding and polishing was performed on a semiautomatic machine Buehler® Phoenix 4000. Grinding was performed with Apex Purple 55 µm, Apex white 15 µm, and then the specimens were polished with diamond 9, 6, 3 an1 µm. EDX analysis was performed on brazing alloy – parent metal (PM) boundary of specimens on JEOL® 7600 F equipment.

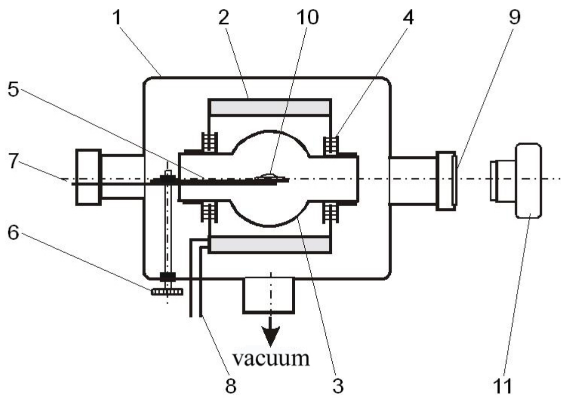

Fig. 1. Schematic representation of apparatus for wetting angle measurement: 1 - vacuum bell, 2 - cooling body of oven, 3 - graphite oven, 4 - fastening ceramic pins, 5 - feeder, 6 – feeder control, 7 - thermocouple, 8 – intake and outlet of cooling water, 9 – observance window for photographing, 10 - specimen, 11 – photographic camera.

3. RESULTS AND ACHIEVEMENTS

3.1. Wettability

Wettability is given by the wetting angle α, which is included by the tangent to brazing alloy surface and parent metal surface. It was assessed during the heating phase at optimum temperature at dwell time for 1 to 5 minutes.

High-temperature brazing alloys type NI 105 and NI 107 wetted the surface of RBSiC. Fig. 2 shows an example of wettability measurement. The results of measurements are shown in Fig. 3. Wetting angle between the RBSiC substrate and NI 102 brazing alloy could not be assessed, since the brazing alloy did not wet this material. The NI 105 and NI 107 brazing alloys have achieved the second degree of wettability – good to very good wettability (20° < α < 40°). At the same brazing temperature the used brazing alloys attain usually first degree of wettability on steels (α < 20°). In case of NI 105 brazing alloy the best wettability was attained at the time of 1 minute and in case of NI 107 brazing alloy at the time of 5 minutes - Fig. 2. However, separation of NI 107 brazing alloy from the PM followed, which was caused due to considerable difference in thermal expansion of materials used.

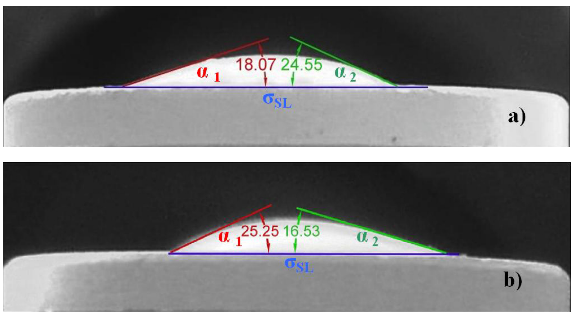

Fig. 2. Wetting angles of RBSiC ceramics (σ_{SL} – PM plane, $\alpha_{1,2}$ – wetting angle): a) NI 105 1190 °C / 1 min., b) NI 107 980°C / 5 min.

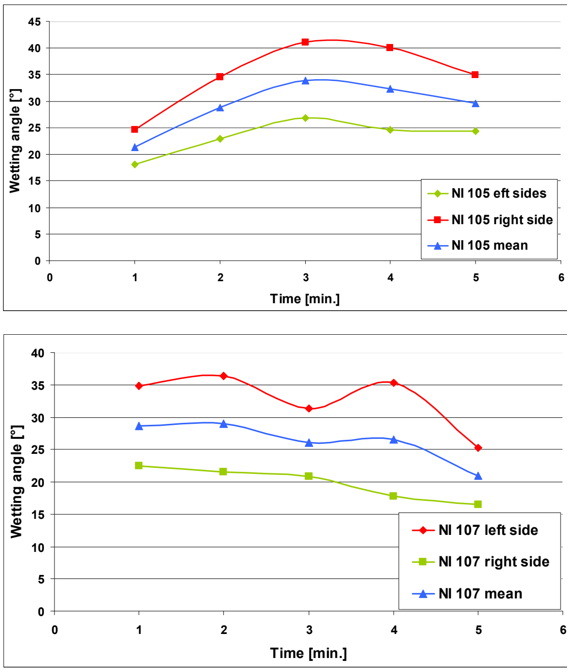

Fig. 3. Wetting angles on RBSiC attained with NI 105 and NI 107 brazing alloys in dependence on dwell time at brazing temperature.

3.2. Interaction of RBSiC and Ni-based brazing alloy

Next assessment was performed with the specimens prepared at optimum brazing temperature and 1 minute dwell time. However, due to extremely different properties, mainly the thermal expansion, a significant damage of brazing alloy and parent metal occurred - Fig. 4. Infiltration of brazing alloy into PM attained 2 to 6 times higher value than usual value of brazing alloy diffusion into PM when applied on steels.

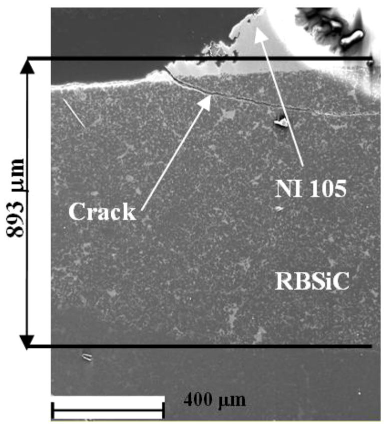

Fig. 4. Infiltration of NI 105 brazing alloy into RBSIC ceramics and crack formation (1190 °C/1 min.)

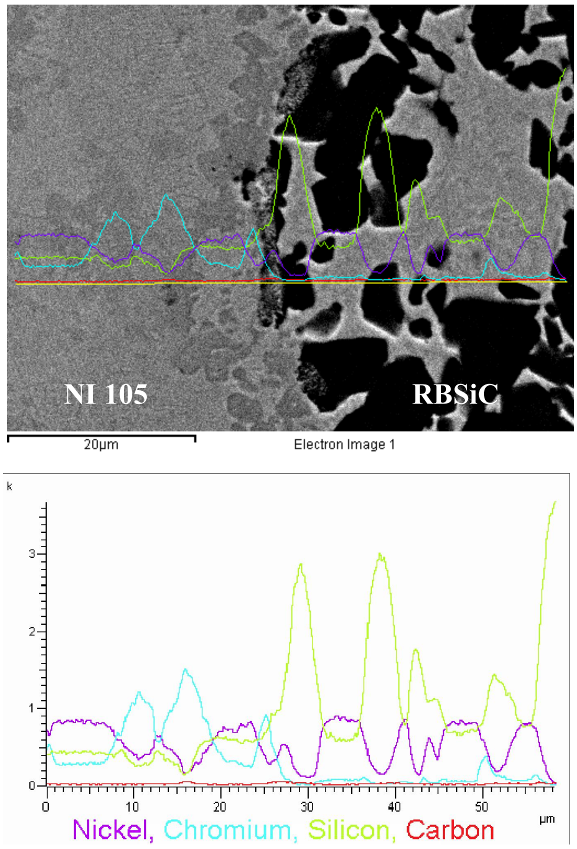

Fig. 5. EDX analysisperfermed on the boundary of RBSiC – high-temperature brazing alloy type NI 105 - 1190 °C/1min.

Fig. 5 shows an example of EDX analysis. In RBSiC ceramics, tha dark zones of – α-SiC and lighter zones – Si can be observed. These zones are typical with considerably lower Si content compared to SiC and with an increased Ni content, which was infiltrated from the brazing alloy. Increased Cr content from brazing alloy was also observed on the α - SiC boundary.

4. CONCLUSIONS

High-temperature brazing alloys type NI 105 and NI 107 have wetted the surface of RBSiC ceramics while achieving very good wettability. EDX analysis has revealed the Ni and Cr from the brazing alloy infiltrated into the zone of free Si in RBSiC. Brazing alloy type NI 105 was assessed as the most suitable. The highest Ni content in NI 105 resulted in faster saturation of Ni-Si phase. In this manner, the depth of infiltration of brazing alloy into RBSiC has reduced and also lower formation of cracks compared to other alloys was observed. However, the joint exerted very low strength.

Improved brazeability of RBSiC by application of Ni-based brazing alloys could be achieved by a suitable modification of chemical composition. Application of suitable alloying elements (Si, Cr, Mo, Ti) should allow the formation of a narrow joint and to prevent the cracking formation.

5. ACKNOWLEDGEMENTS

RNDr. Pavol Šebo, DrSc. And Mária Bachratá, Institute of Materials & Machine Mechanics, SAV for preparation of specimens. RNDr. Pavol Priputen, PhD. for EDX analysis. The contribution was prepared with the support of VEGA 1/0211/11 project - Development of lead-free solder for higher application temperatures and research of material solderability of metallic and ceramic materials.

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Optimization of business logistics processes through RFID

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Abstract

Radio frequency identification technology (RFID, for short) is without doubt one of the most discussed topics today. Accordingly, this article which can be divided into three main parts, deals with RFID issues, as well as with the optimization of business logistics processes through RFID. In the first part is briefly analyzed the current state of RFID use in Slovakia. Forasmuch as the greatest interest in RFID implementation is registered just in the automotive industry, in the second part are presented various problem areas, which are registered either in the automotive industry or generally in all plants with rotating pallets. In the third, final part is further characterized the business logistics processes course, using RFID. Based on these problem areas, as well as their possible solutions through radio frequency identification technology, it may finally be noted that RFID is an important agent in the optimization of business logistics processes.

Keywords: Engineering; Industrial logistics; Logistics processes optimization; Radio frequency identification.

1. INTRODUCTION

Radio frequency identification (RFID, for short) is without doubt one of the most discussed topics today. In literature, as well as numerous articles, it is possible to encounter with many conflicting views of experts from different sectors. While one rejects RFID for its insecurity and high costs associated with its implementation, others see RFID as virtually the only one initial solution of current situation.

The fact is, that many successfully implemented projects clearly testify in its favour. Accordingly, this article deals with the issue of radio frequency identification, as well as the possibility of business logistics processes optimization through RFID.

2. RFID IN SLOVAKIA

Radio frequency identification in Slovakia is not yet widely used. According to a survey of the use of information and communications technologies, which was conducted by the Statistical Office of the Slovak Republic, RFID technology uses less than 5% of businesses with ten or more employees.

48.6% of enterprises using RFID technology to access control or personal identification.

Less than 17% of enterprises use this technology to label their products to protect against theft and the same percentage of companies to monitor stocks and flows in their supply chains (1, 2).

Greatest interest in the introduction of radio frequency identification is currently registered in the automotive industry and in the warehouse and production management.

The automotive industry in Slovakia is without doubt the most important branch of Slovak industry, which is characterized by high inflows of foreign investment, increasing support from the state and ultimately by the use of new technologies.

Automotive industry at the head of operations with rotating pallets, represents an ideal field for RFID application in Slovakia.

3. PROBLEM AREAS AND THEIR SOLUTIONS

The first problem area is associated with already mentioned actual cycle of pallets, also known as reusable transport items or containers between suppliers and manufacturing plants. Problems in this area can be further divided into five groups:

- **lack of awareness of the availability of empty pallets**, which causes further problems with the storage space,
- **excess of pallets**, which is caused by additional ordering of pallets and their unknown status on the stock. These pallets require more storage space and also generate additional costs associated with their storage.

These containers must be accurately calibrated and therefore they are subject to routine check. However, they are currently not being monitored in which cycle they occur. Therefore, there are cases when the uncalibrated container gets into the production process which will cause the shutdown of the robot, as well as the whole production line that is not able to operate them. This will trigger large losses in just a few minutes.

The individual business logistics processes course without the support of radio frequency

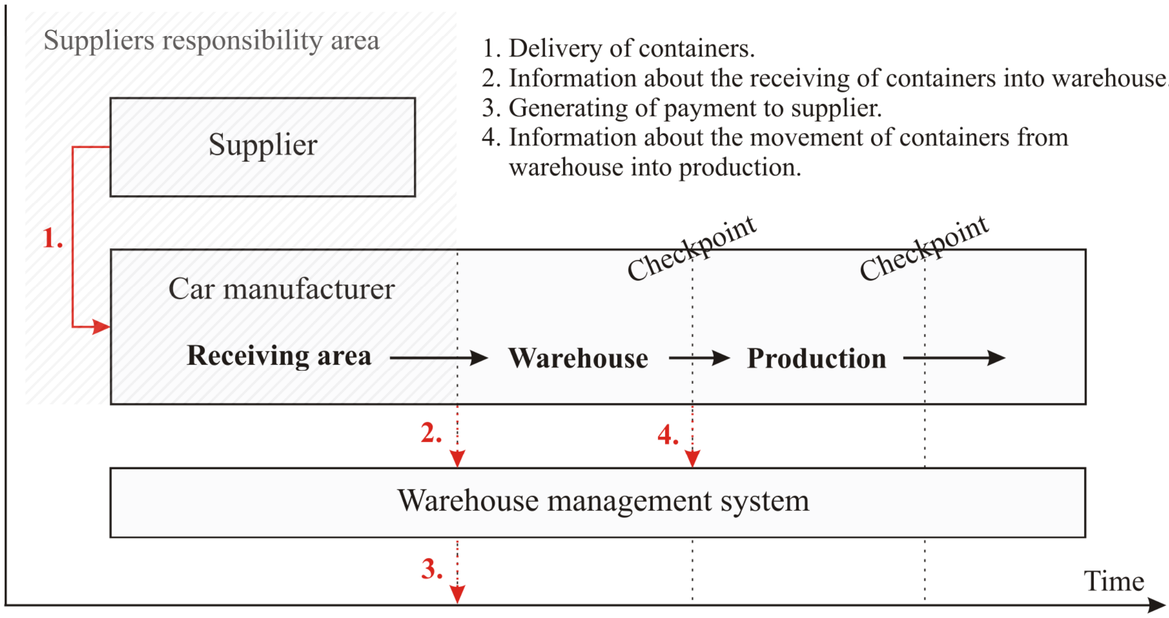

Fig. 1. Business logistics processes course without the support of RFID (own processing)

- **wrong delivery of pallets** - in this case, the pallets must be returned which creates additional costs associated with their transport to the right place,
- **thefts and losses of pallets**, which generate additional costs associated with buying or renting pallets,
- **special transfers of pallets due to their unstable distribution**, in order to cover deficiency of pallets.

The second problem area is associated with the actual movement of pallets or containers within the company. It is talking about the special containers which are designed for robotic workstations, i.e. robots, which take the individual parts out of these pallets and assemble the body of them.

identification is shown in the figure below. It focuses on the problem area from shipping containers to the car manufacturer to their use in the production.

Another problem is that suppliers are unable to flexibly respond to the manufacturers requirements. Suppliers deliver the individual parts on the basis of orders generated from the total order by managing clerks. Suppliers deliver the required containers, but they do not know when the containers are depleted, because they actually have no access to the factory warehouse systems.

Finally, it is necessary to mention the fact that some parts that are in a way damaged, get into production too. These parts are not used, but the payment has been already generated on their arrival to the warehouse which can create further problems associated with their complaints.

Currently, from the trio of Slovak automotive plants that does not use RFID technology in the production or storage is Trnava PSA Peugeot Citroën. Volkswagen uses RFID tags to manage autonomous trucks at various production places and RFID plan to introduce in their near future to control the flow of supplies. Kia already has experience with RFID and uses this technology in body shop almost since the start of production (2).

The individual business logistics processes course supported by RFID technology can be illustrated by the following figure.

including which parts are required and the sequence in which they go into the production.

The automatic system correctly assigns the individual parts to the cars and also prevents the confusion in order of palettes (2).

The RFID technology also brings the solutions to other already mentioned problematic issues. On receipt of the containers into the warehouse and their movement from warehouse to production, the information is sent to the factory warehouse system.

This information may be sent into the RFID web application that can be easily accessible to all suppliers. Suppliers are also informed immediately when the containers are used and

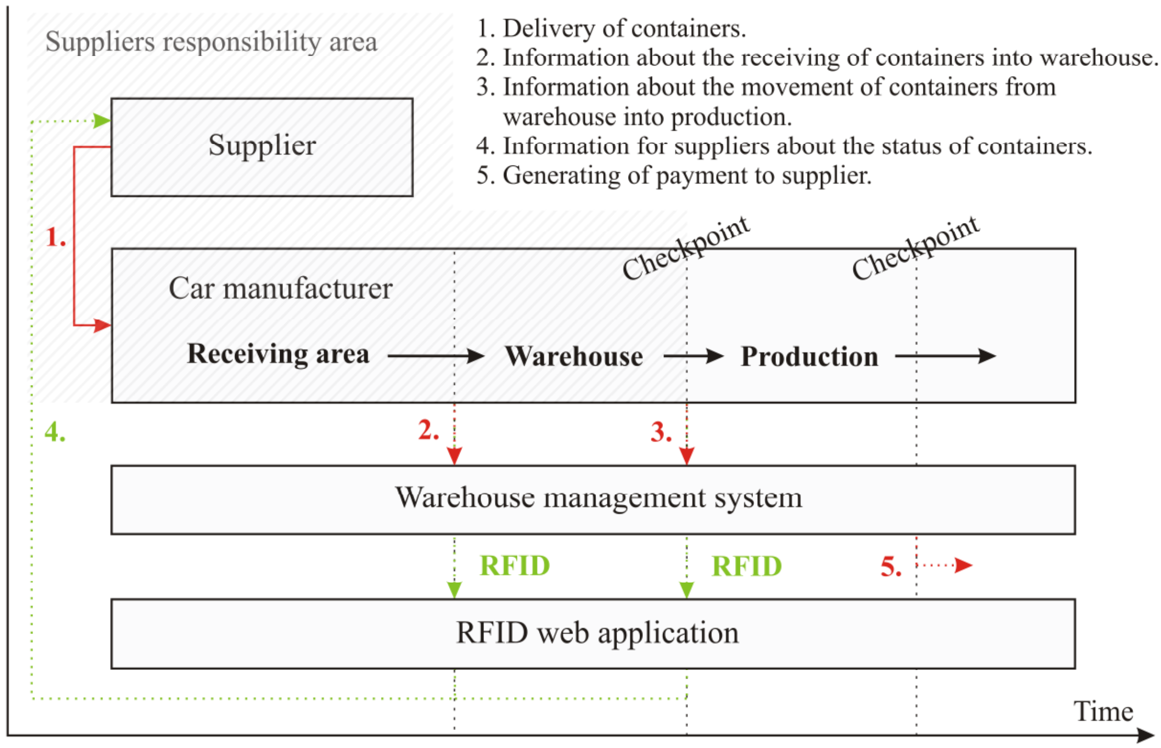

Fig. 2. Business logistics processes course with the support of RFID (own processing)

Suppliers deliver individual parts on special pallets that are marked with RFID tags. On their arrival, the data from the individual labels are loaded into the information system and the robot stores them according to their positions. After receiving request from the production, they will be removed automatically.

The robots select the individual parts and assemble the body of them. All this happens automatically without human intervention. RFID tags store the information about the car

can respond flexibly.

In addition, the company will obtain an overview of the actual position of the containers as well as their time of use. Based on this information, the payments to the suppliers can be generated. Therefore company will pay only for those containers that will be used.

The current cycle of the container can be tracked through RFID tags or transponders. This will eliminate the danger that some uncalibrated container gets into production.

Given that the whole process of identifying of individual containers begins at the supplier, all of these problems associated with the cycle of containers between manufacturing plant and supplier can be removed and the storage space costs as well as the costs associated with their search and their transport to the right place significantly reduced.

These problem areas are not related just to the automotive industry. As mentioned earlier, this is virtually related to all manufacturing operations with rotating pallets or containers. RFID technology would be also able to resolve the problem areas in other branches of industry.

4. CONCLUSIONS

Based on the above examples of RFID technology use, various problem areas and ways of their solutions can be finally concluded that RFID technology is crucial in the process of increasing the efficiency of business logistics processes.

The introduction of RFID technology represents a single investment for the company that allows optimization and improvement of logistics processes efficiency, virtually in all problem areas at once.

The resulting effect is not only broader, but also more qualitative valuable than the effect that could be reached through the targeted optimization or improving the efficiency of logistics processes particularly in all individual problem areas.

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Wettability and Interactions of BiAg11 Solder with Cu, Ag and Ni Substrates

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Abstract

The aim of this contribution is to study interactions between BiAg11 solder and Cu, Ag and Ni substrates. A degree of interaction was determined on the basis of wetting angles. The best wetting angle of 18° was measured in the case of Ag substrate with the application of flux. Unsatisfactory wetting angle of 146° was attained in the case of Ni substrate with the application of flux. The sizes of wavy interfaces were determined by the EDX analysis and the aim of this experiment was to find out in which cases the application of substrates resulted in the formation of intermetallic compounds and when only a eutectic reaction occurred.

Keywords: Solder; BiAg11; Wettability; Transitional area; EDX analysis.

1. INTRODUCTION

Sn - Pb based alloy was the most commonly used solder alloy for electronic industry. The harmful effects of lead are generally well known, and therefore, all soldering materials are being substituted for lead - free ones. However, PbSn5 and PbSn10 solders with high lead content are still utilized in the applications where higher temperature is required because no existing substitutes has been developed. But there are alternative solders whose qualities are similar to lead - containing solders [1, 2].

These include precious metals such as gold (AuSn20, AuGe12) and silver (BiAg11, SnAg25Sb10). BiAg11 solder was chosen for the experiment, because of more affordable price than Au based solders and higher melting point in comparison to SnAg25Sb10 solder [2].

Many contributions focused on BiAg11 solder properties. The interaction among BiAg11 solder with metallic substrates were studied at Tsingua university in Beijing. Institute of Multidisciplinary research for advanced materials at Tohoku university deals with thermodynamic properties and evaluations of lead-free solders for higher working temperatures. Tensile strength and ductility of BiAg11 solder was tested [2, 3].

2. SOLDER MATERIALS

Cu, Ag and Ni substrates as well as solder consisting of 89% of Bi and 11% of Ag were chosen for the experiment. Not only the melting point must have been in the range between 260 °C and 450 °C but also solder must have had satisfactory tensile strength and be at reasonable price. Vacuum casting was performed in order to ensure the 99.99% purity of the solder alloy [3]. The sizes of samples were 40 x 40 x 2 mm.

A production procedure of the first three samples began with putting 1 gram of BiAg11 solder to the centre of clean and degreased surface of each sample. Samples were soldered in an air furnace at the temperature of 380 °C and during 30 minutes endurance at this temperature. A production procedure of other three samples was similar with the difference that in addition to 1 gram of BiAg11 solder we added flux of the Soldaflux type 7000 (3.1.1.A). Samples were soldered in an air furnace at the temperature of 380 °C. However, endurance at this temperature differed and it was only 10 seconds.

The aim of the experiment was to learn about the interactions between BiAg11 solder and Cu, Ag and Ni substrates and also to determine the influence of flux and its effects [9]. The level of interaction was determined on the basis of wetting angles. Tests of wettability of BiAg11 solder were conducted with the help of goniometric method. The lower is the angle, the better interaction can be expected. Flux can help the interaction but it depends also on the type of substrate.

Samples were prepared metalographically with the aim to determine the contact wetting angles and perform observations at the solder - substrate interface. Because of the fact that samples were in corroded state the results proved the presence of phases and visible wavy interfaces [4, 7].

The EDX analysis was utilized to monitor the change in concentration of elements on determined line through defined area of phase interface. These areas included the areas of dark phases, matrix and the areas of phase interface.

3. RESULTS

3.1. Measurement of wettability angles

First, the samples with Cu substrates were measured. The sample without the application of flux had the wetting angle of 91° which means unsatisfactory wettability (fig. 1 a). Negative effects included the formation of visible hollows. On the contrary, in the sample with the application of flux the wetting angle was 25° which means good wettability (fig. 1 d).

Satisfactory results were recorded in both cases when samples with Ag substrates were utilized. The sample without the application of flux had the wetting angle of 36° which means good wettability (fig. 1 b) and the sample with the application of flux had very good wettability of 18° (fig. 1 e).

The results of samples regarding wetting angles with Ni substrates were as follows. In case of the sample without the application of flux the angle was 40° which still means good wettability (fig. 1 c). Unsatisfactory value of 146° was recorded in the sample with the application of flux (fig. 1 f). Visible gap between BiAg11 solder and Ni substrate proves that there are unwetted areas.

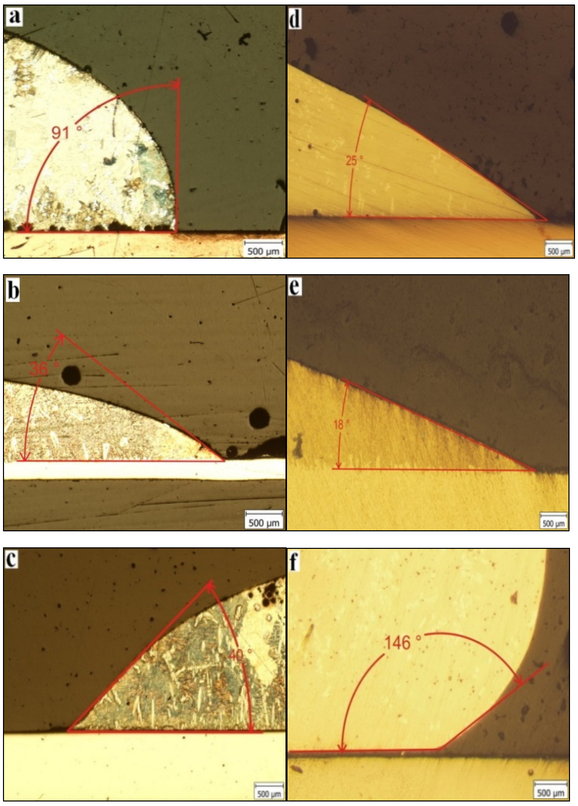

Fig. 1. Angles of wettability on Cu (a), Ag (b) and Ni (c) substrate without flux and Cu (d), Ag (e) and Ni (f) with flux

3.2. EDX analysis

Based on the images from the EDX analysis it is visible that Cu does not dissolve neither in Bi nor Ag. Independently on the fact whether flux has been applied or not, there was no intermetallic compound between Bi and Cu elements, and only a eutectic reaction occurred with expected weak interaction between solder and the Cu surface at the temperature of 270 °C. The size of wavy interface reached 5 µm for the sample without flux (fig. 2 a) and 1 µm for the sample with the application of flux (fig. 2 b). Eutectic reaction was not significant as well [5].

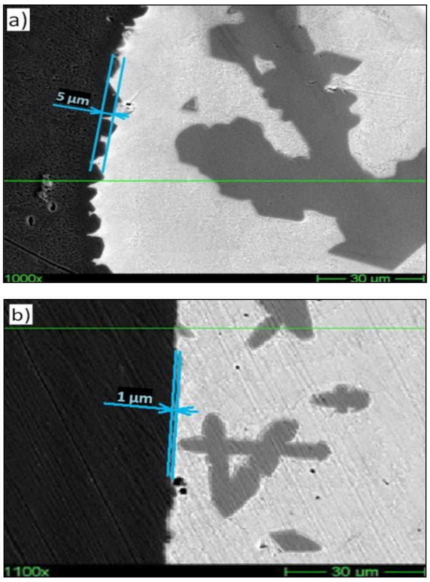

Fig. 2. EDX analysis of BiAg11 solder- Cu substrate fabricated without the application of flux (a) and with the application of flux (b)

During soldering Ag substrates with BiAg11 solder, a eutectic reaction with more significant interaction between solder and surface occurs. There is a higher probability that primary material will be wetted. The more significant eutectic reaction occurs, the bigger is the waving effect.

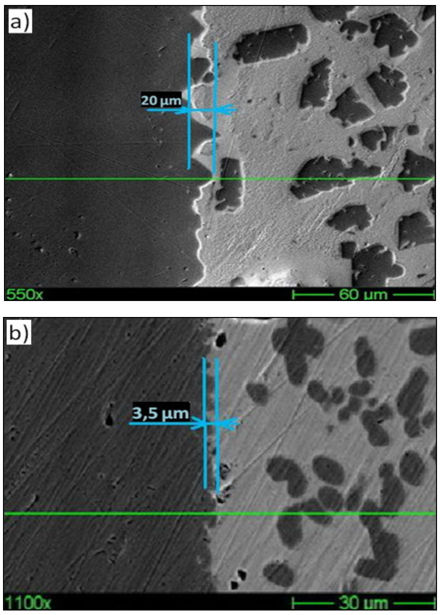

Fig. 3. EDX analysis of BiAg11 solder- Ag substrate fabricated without the application of flux (a) and with the application of flux (b)

The size of wavy interface of 20 µm for sample without the application of flux is depicted on the (fig. 3 a) and size of 3.5 µm for sample with the application of flux is depicted on the (fig. 3 b). The complexity of this process is determined by low solubility of Ag in Bi in the liquid state.

During the interaction of BiAg11 solder with Ni substrate, the formation of inter-layer of chemical compound is expected. According to Ni - Bi binary diagram, the formation of $NiBi_3$ intermetallic compound is the most probable at the temperature of 271°C. Then Ni dissolves to $NiBi_3$. The width of formed $NiBi_3$ intermetallic compound was about 20 µm for sample without the application of flux (fig. 4 a) and 5 µm for sample with the application of flux (fig. 4 b).

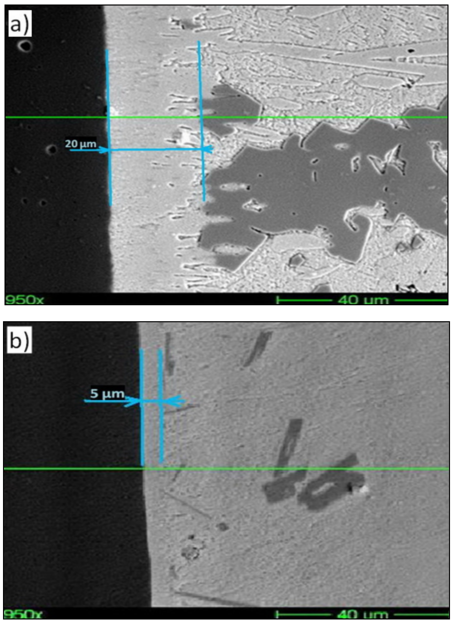

Fig. 4. EDX analysis of BiAg11 solder- Ni substrate fabricated without the application of flux (a) and with the application of flux (b)

3.3. Optical microanalysis

Areas of phase boundaries and the microstructure, which are obtained by optical microscopy are clearly visible in following figures.

Various precipitated particles of the second phase rich in Ag, can be observed in the Bi rich primary phase (fig. 5 a, b, c) without the application of flux and (fig. 5 d, e, f) with the application of flux.

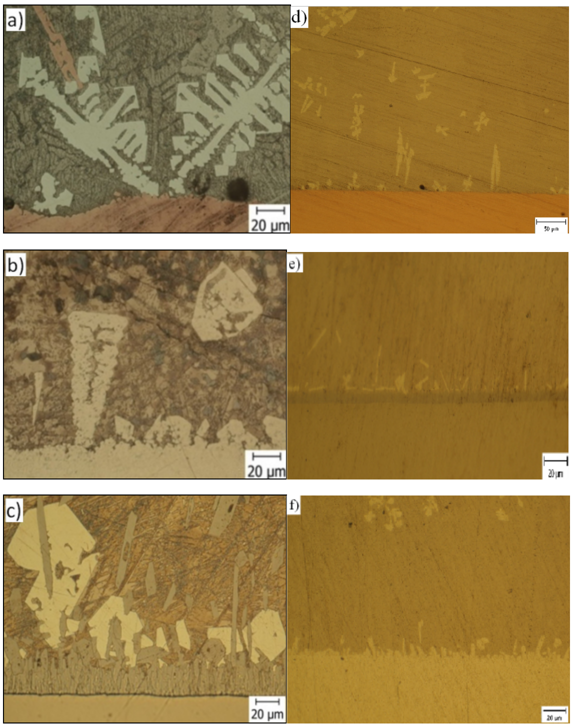

Fig. 5. Cu (a), Ag (b) and Ni (c) substrate without the application of flux and Cu (d), Ag (e) and Ni (f) with the application of flux - solder phase interface

4. CONCLUSIONS

Better results were recorded with Cu and Ag substrates when flux of the Soldaflux type 7000 (3.1.1.A) was applied. The results of wetting angles were 25° for Cu substrate and 18° for Ag substrate which means that both materials are suitable for BiAg11 solder and for its potential application in the practice [6, 9]. In case of Ni substrate it is better not to apply flux. The results of wetting angles are only then satisfactory. In the near future, BiAg11 solder has a good perspective to be used in electrical engineering in soldering printed circuit boards directly on conductive surface [8, 10]. It is the first economically advantageous lead - free solder which can be used to solder printed circuit boards and which is able to withstand the temperature of 260 °C during reflow soldering.

5. ACKNOWLEDGEMENTS

The author thanks to prof. Ing. J. Lokaj, PhD. for EDX analysis. This contribution was prepared with the support of the project VEGA 1/0211/11 Development of lead-free solder for higher application temperatures and research of material solderability of metallic material.

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Application of CBN Diffusion Coatings on Metal-Cutting and Cold Forming Tools

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Abstract

CBN diffusion coating produced thermo-chemically on the ball nose end mills made of AISI-M35 high speed steel (HSS) has been studied. The microstructure and the component depth profiles of the CBN diffusion layer have been investigated using scanning electron microscopy and energy dispersive X-ray spectrometry. The results on the industry cutting tests of the metal-cutting and cold forming tools with and without complex CBN diffusion coatings are also introduced in the paper.

Keywords: Diffusion coatings; Microstructure; Properties; Cutting tool; Forming Tool.

1. INTRODUCTION

The major recent advances in cutting tool materials are dealt primarily with application of different coatings on the cutting tool material substrate [1-3]. In cutting-tool industrial sector about 50 % of all cutting-tools are made of HSSs and more than 50% of them are coated [4]. A substantial part of cemented carbide cutting tool materials are also coated. Coatings improve the tribological conditions in various metal cutting operations primarily due to decrease of friction coefficient and reduction in cutting forces and temperature at the tool-workpiece interface, and thus benefit to increasing cutting speed and productivity of machining. Application of coatings for HSS tools used in automotive industry are also known and results in at least two times increase in the allowed cutting speed (up to 70–80 m/min) and three–five times increase in tool life (for modern hobs with TiAlCrN coating) [5].

Chemical vapour depositing (CVD) and physical vapour depositing (PVD) are the most promising techniques for coating development on various metal cutting tools since these techniques allow the deposition of a variety of compounds and corresponding structures with high resistance to wear and enhanced stability at elevated temperature. But the high deposition temperature 950-1050 °C during CVD can result in structure degradation of a HSS substrate, and as consequent, this technique is only used for cemented carbide materials. This is not the case for PVD, where deposition temperature normally can be kept in the range of 20-1000 °C that makes this technique appliable for HSSs too. On the other hand, the equipment for PVD technique is relatively expensive, and for this reason the process of physical vapour deposition is not economically attractive for small series of metal cutting tools.

From this point of view, application of low-temperature thermo-chemical processes for developing diffusion coatings with high wear resistance on the finished surfaces of metal cutting tools made of HSSs seems to be very attractive. The purpose of the present study is to investigate the microstructure and tribological properties of thermo-chemically coated (carbon – boron – nitrogen) AISI-M35 HSS ball nose end mills.

2. METHODS AND MATERIALS USED FOR RESEARCH

The CBN diffusion coating was thermo-chemically developed on the commercially manufactured and heat treated ball nose end mills. Zinc phosphate coating was also commercially applied to these ball nose end mills by the manufacturer. After the zinc phosphate coating have been deposed the helical margin grinding was only carried out.

Thermo-chemical treatment was selected due to its ability to form highly effective coating in a very simple way, at relatively low temperature without use of special technological equipment. It worth mentioning, that this technique allows combining coating development on the metal cutting tool with its tempering. Bimetal ball nose end mills (10 mm diameter, 70 mm length, and four flutes) with the tool body length of 40 mm made of AISI-M35 HSS were used as the tool substrate. The chemical composition of the substrate (tool body) was as follows, mass%: 0.84 C; 0.33 Si; 4.1 Cr; 6.2 W; 5.1 Mo and 4.9 Co. Six mills were divided into two parts. One part, consisting of 3 pieces, was used for producing diffusion coating while another part was used as-received.

To produce coating, the ball nose end mills were placed into container and then filled up with powder mixture containing diffusion-active components (Fig. 1). The container covered with the lid with sand lock was placed into ordinary chamber electric furnace with air atmosphere followed by its holding at a temperature of 550 °C, until full heating to this temperature was completed and then additional holding for 1 h in order to produce CBN diffusion layer. After cooling to room temperature the ball nose end mills with the coating were taken out of the container and investigated together with other similar mills without the coating.

Scanning Electron Microscopy (SEM), using a JEOL JSM–7600F, equipped with an Oxford Instruments Energy Dispersion Spectroscopy (EDS) facility, was applied for the examination of microstructure of the coatings and substrate. The thickness of the CBN diffusion layer produced thermo-chemically were measured in cross-sections of the samples in the SEM.

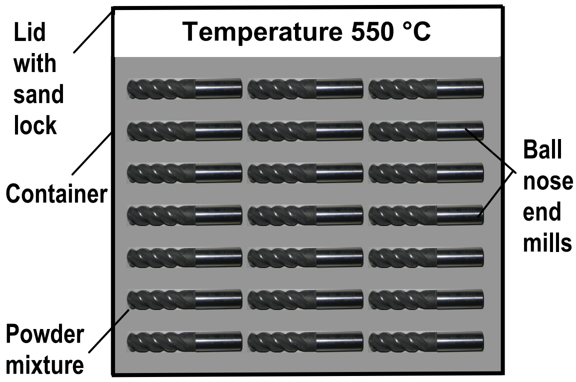

Fig. 1. Schematic illustration of the thermo-chemical device used for the diffusion coating developing

3. RESULTS AND ACHIEVEMENTS

The general view of the CBN diffusion coating on the HSS substrate is shown in Fig. 2a. The microstructure of the HSS substrate consisting of the tempered martensite and the alloy carbides of eutectic origin is seen in Fig. 2c. Two types of carbides have been revealed in the HSS substrate. According to the EDS the larger light-coloured carbides are of M_6C type, and a bit smaller dark ones are of MC type (Fig. 2c).

The thickness of the diffusion coating is about 2 μm (Fig. 2b). No columnar growth which is more typical for high temperature technology, e.g. for conventional boronising, is evident. Nano-sized rounded grains of about 50 nm in diameter can be observed (Fig. 2d). Due to extremely small size of the coating layer formed on the complex surface of the tool, there was no possibility to detect the origin of this nanostructured phase (phases) by used techniques.

The EDS analysis shows the elemental spectra of the thermo-chemically coated tool as presented in Fig. 3. The diffusion redistribution of the elements between the substrate and the coating can be also found on their concentration profiles in Fig. 4.

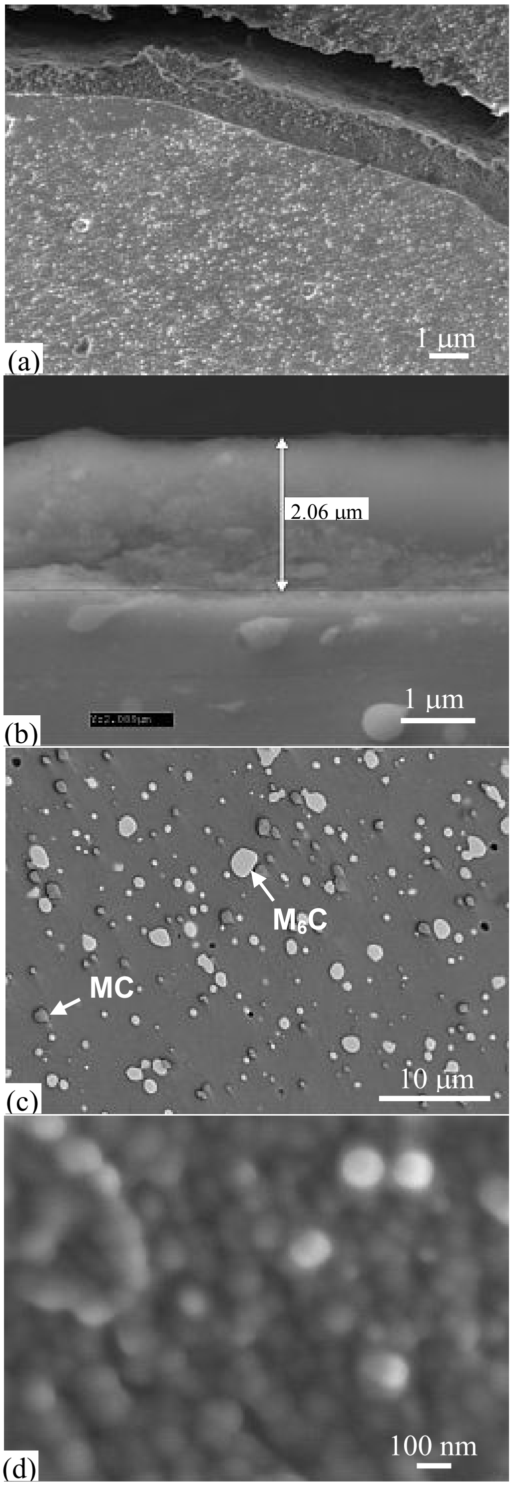

Fig. 2. (a, b) General view and microstructure of (c) the HSS substrate and (d) the diffusion coating

It is seen from Fig. 3 and Fig. 4 that all elements used for developing the coating including calcium and silicon which were employed to accelerate primarily the diffusion of boron at a low temperature, according to their pattern of distribution between the substrate and the coating can be divided into 2 groups. Boron, carbon and oxygen have their stronger peak of a maximum concentration in the very coating layer and considerably weaker second peak in a narrow zone between the coating and the HSS substrate. Just on the contrary, nitrogen and silicon primarily diffuse to this narrow zone between the coating and the HSS substrate. This is not the case for calcium which primarily diffuses only to the coating.

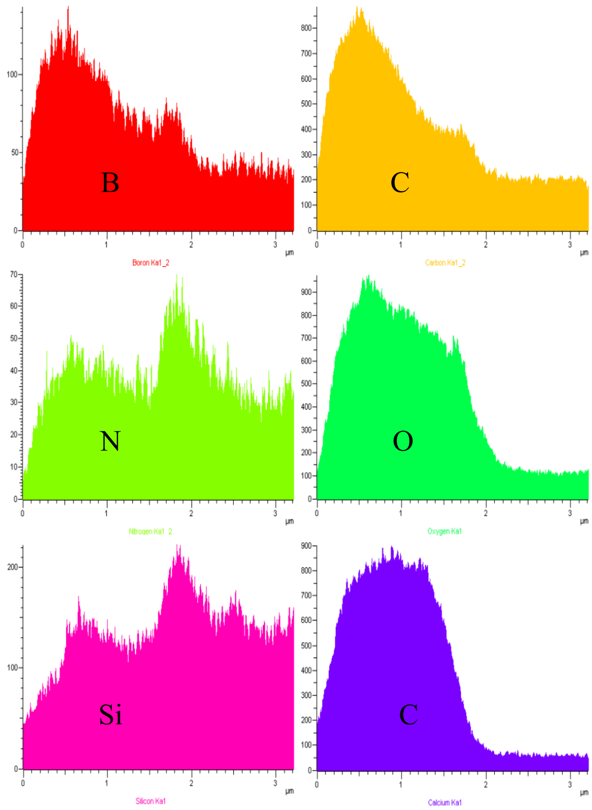

Fig. 3. Elemental spectra of the elements in a cross-section of the diffusion coating and the substrate

So-called "self-organized" phases can be formed on the cutting surface as a result of a reaction between oxygen, which comes from the environment, as well as the tool material [6], in our case, the diffusion coating components. For this reason, formation of the (C, B, N, Ca, Si)–O types phases with excellent tribological properties most probably takes place on the thermo-chemically coated tool surface during developing coating and cutting operation. This assumption is in a good correlation with the EDS results which show the presence of a large amount of oxygen in the diffusion coating.

In our previous paper [7] the cutting tests carried out using a milling centre (EAGLE

1000) by machining annealed AISI-1060 (HB 200) spring steel showed that the CBN diffusion coating reduced significantly the wear of the ball nose end mills. Application of the CBN coatings for other kinds of the tools resulted in their tool life increase as follows: 7 – 10 times for the taps, 2.2 – 2.5 times for the reamers, 2 – 2.3 times for the twist drills and 8 – 10 times for the punches.

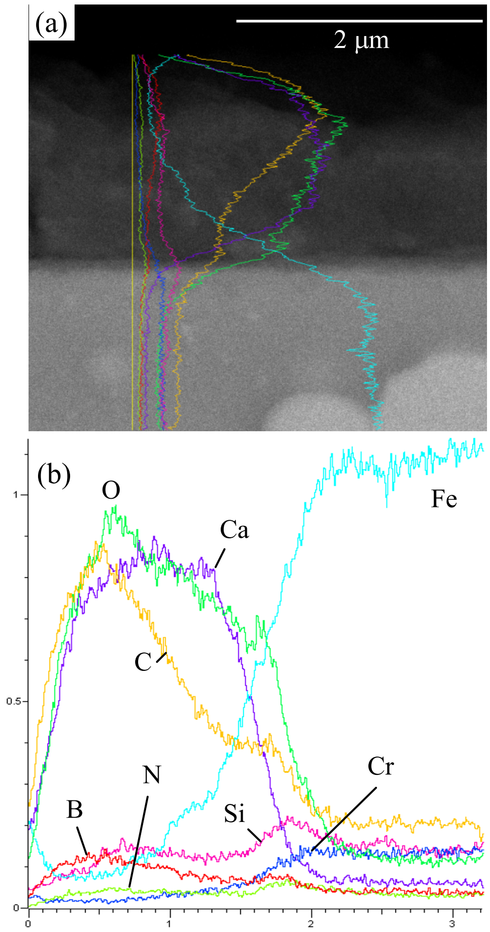

Fig. 4. (a) SEM image and (b) concentration profiles of the elements in a cross-section of the diffusion coating and the substrate

4. CONCLUSIONS

The obtained results show that well adhered CBN diffusion coating can be thermo-chemically developed only at 550 °C for 1 h on the HSS substrate. In this case the CBN diffusion layer develops in the nano-sized microstructure consisting of the rounded grains with about 50 nm in diameter. Employment of the CBN diffusion coatings is very effective from the viewpoint of the wear resistance and the tool life of the metal-cutting and cold forming tools. The industry cutting and forming tests have shown that the tool life of the metal-cutting and cold forming tools with CBN diffusion coatings can be a factor of several times higher than that of the identical tools without CBN diffusion coatings.

5. ACKNOWLEDGMENT

The financial support of the grant from the Ministry of Education of the Slovak Republic VEGA 1/0099/10 is gratefully acknowledged.

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Application of Diffusion Boronized Layer on Forging Die

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Abstract

Diffusion boride layer has been produced on the surface of a hot work tool steel. The microstructure and elemental spectra as well as depth profiles of the elements in the boride layer have been studied by scanning electron microscopy, X-ray diffraction analysis and energy dispersive X-ray spectrometry. Micro-hardness measurement was carried out using the Vickers micro-hardness test. The results showed that the boride layer is formed by boron compound Fe_2B. Additionally, boron carbide B_4C has been revealed embedded in the bulk of the boride layer.

Keywords: Die steel; Boron diffusion layer; Microstructure; Properties.

1. INTRODUCTION

The surface properties of structural and tool materials can be modified by surface engineering using two distinctly different approaches to the various methods for surface hardening [1]. The major recent advances in both cutting and die tool materials are dealt primarily with application of methods that provide an intentional build up or addition of a new layer on the cutting and die tool material substrate [2, 3]. Among these methods, chemical vapour depositing (CVD) and physical vapour depositing (PVD) are the most promising techniques for surface hardening of various metal cutting and die tool materials since these techniques allow the deposition of a variety of compounds and corresponding structures with high resistance to wear and enhanced stability at elevated temperature. Thin coatings improve the tribological conditions in various metal cutting and forming operations primarily due to decrease of friction coefficient and reduction in working forces and temperature at the tool-workpiece interface, and thus benefit to increasing productivity of machining and forming.

The second group of surface hardening methods includes the use of diffusion methods which modify the chemical composition of the surface with hardening active elements such as carbon, nitrogen, boron, or their combination. Diffusion methods allow effective hardening of the entire surface of a tool and development of a diffusion layer which case depth can very widely.

In general, typical diffusion treatments are carburising, nitriding, carbonitriding, and boronizing. Despite the resent development in PVD and CVD coatings has offered significant benefits in terms of improved wear resistance and stability at elevated temperature, diffusion treatments are still widely used for varieties of different classes of materials such as low-carbon steels, low-carbon alloy steels, alloy steels, nitriding steels, stainless steels, most ferrous metals including cast irons, and tool steels.

Boronizing can be applied to all above mentioned classes of materials as well as to non-ferrous materials and cermets offering in all cases extremely high hardness values of boride layer that is the main advantage of the process compared to other diffusion methods. Due to this feature, boride layer has extremely high wear resistance. It is necessary to emphasize that high hardness of boride layer can be retained at elevated temperature that is very important for both cutting and forming tools exposed to high temperature load during exploitation. Other advantages of boride layers such as enhanced corrosion-erosion resistance and oxidation resistance at elevated temperatures have been also reported [4-6].

The boronizing process is carried out at temperature in the range of 700-1000 °C with holding duration in the range of 1-12 hours. There are different techniques used for a diffusion-controlled surface hardening treatment resulting in diffusion and subsequent absorption of active boron atoms into the substrate surface. The boronizing process can be held using solid, liquid or gaseous medium. Plasma boronizing and fluidized bed boronizing techniques can be also applied for boride layer development.

In all these techniques, the mechanism of boronizing is generally known, but the specific reactions that take place in different materials and with different boronizing media are not always known especially in the case of tool steels. For this reason, the purpose of the present study is to investigate the microstructure and microhardness of boride layer developed on the surface of a die steel.

2. METHODS AND MATERIALS USED FOR RESEARCH

The boride layer was thermo-chemically developed on the surface of the cast hot work tool steel, which chemical composition is shown in Table 1. The steel was melted in an electric high-frequency induction furnace. The ferromanganese, ferrosilicon, and metallic aluminium were used as deoxidisers. Inoculating treatment of the parent alloy melt was carried out using additions of the metallic titanium (0.1 wt. %), niobium (0.1 wt. %) and nitrogen (0.05 wt. %). The melt of the steel was poured into ceramic moulds, made by Shaw technique, with the aim of producing die inserts. The mass of the die inserts was 40 kg. Heat treatment of the specimens prepared from the experimental ingots included annealing carried out at 880 °C for 2 h followed by slow cooling to 720 °C and holding at this temperature for 4 h.

To produce boride layer, powder-pack boronizing method was utilised. The specimens were placed into metallic container and then filled up with powder mixture Durboride, containing diffusion-active components. The lid of the container was tightly sealed using metallic plate, covered with the crashed glass, and Al_2O_3 fibre along its perimeter as seen in Fig. 1. Then, the container was placed into ordinary chamber electric furnace with air atmosphere followed by its holding at a temperature of 1000 °C for 4 h in order to produce boride diffusion layer. At high temperature, the crashed glass was melted penetrating into Al_2O_3 fibre. After holding, one part of specimens was cooled in still air and another part was slowly cooled into the switched out furnace.

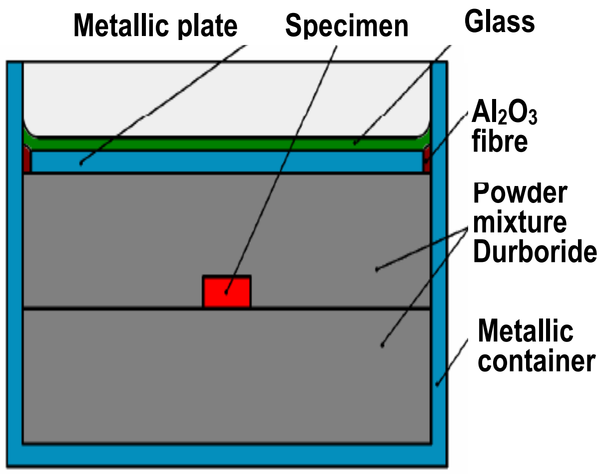

Fig. 1. Schematic illustration of the thermo-chemical device used for the boride layer developing

The metallographic specimens were prepared by standard procedures. Before it, these specimens were covered with thin nickel coating to avoid boride layer cracking of during specimen preparation. After grinding and polishing, the specimens for light metallography were etched in Nital etchant. Scanning Electron Microscopy (SEM), using a JEOL JSM–7600F, equipped with an Oxford Instruments Energy Dispersion Spectroscopy (EDS) facility, was applied for the examination of microstructure of the substrate and boride layer. X-ray diffraction analysis (XRD) was also performed.

Micro-hardness measurement was carried out using the Vickers micro-hardness test with 0.1 kg load. Ten measurements were made for each sample to obtain satisfactory statistical reliability.

3. RESULTS AND ACHIEVEMENTS

The general view of the diffusion boride layer and the steel substrate after cooling into the furnace and in still air is shown in Fig. 2. It is seen that the microstructure of the steel substrate differs in both cases depending on the cooling rate. Cooling into the furnace results in microstructure of the steel substrate with microhardness of 457 HV0.1, while cooling in still air leads to the formation of transformation products in addition to martensite. In this case microhardness of the steel substrate is considerably higher, 626 HV0.1

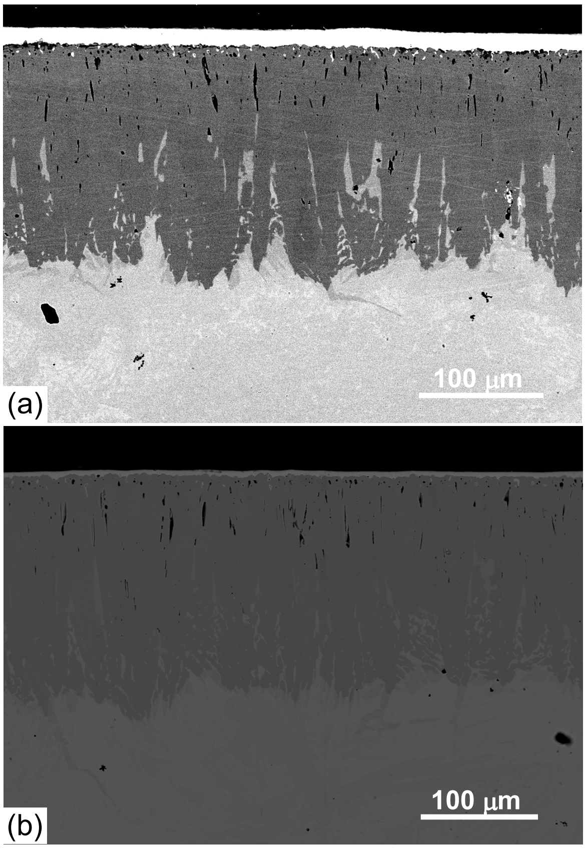

Fig. 2. (a, b) Microstructure of boride layer after cooling (a) into the furnace and (b) in a still air

As for the microstructure of boride layer that seems to be similar in both cases. According to the XRD analysis the saw-tooth shape boronized diffusion layer (Fig. 2) is formed by boron compound Fe_2B. The thickness of the boride layer is in the range of 140-170 μm in the case of cooling into the furnace and 170-210 μm in the case of cooling in a still air. The microhardness of the boride layer is 1449 HV0.1 in the case of cooling into the furnace and 1408 HV0.1 in the case of cooling in still air. This means that the higher cooling rate of the specimens after boronizing operation the lower microhardness of the boride layer.

The EDS analysis shows elemental spectra of the thermo-chemically surface hardened specimens as presented in Fig. 3 for the case of the cooling in the furnace.

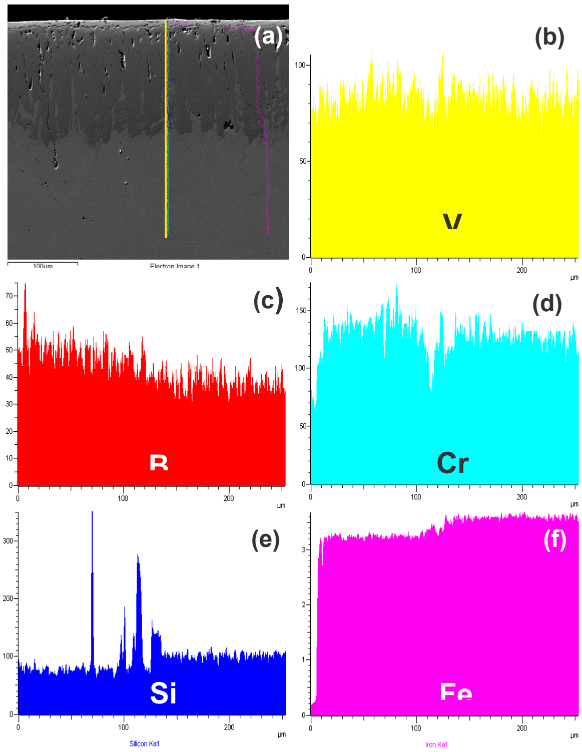

Fig. 3. (a) SEM image and (b-f) elemental spectra of the elements in a cross-section of the boride layer and the substrate after cooling into furnace

The diffusion redistribution of elements between the substrate and the boride layer seem to be typical for the applied technique for developing the boride layer. In both cases, the main feature is that silicon does not dissolve significantly in the boride layer, and being diffused away from the boride layer to the steel matrix by boron forms, probably, iron silicoborides in the transition zone of the diffusion layer. This assumption can be argued by the fact that silicon has its stronger peaks of a maximum concentration in the transition zone of the diffusion layer in both cases, as seen in Fig. 3e. The higher concentration of iron in the transition zone, compared with that in the very boride layer (Fig. 3f) is also in line with this assumption. Just on the contrary, chromium has the lowest concentration in the transition zone (Fig. 3d), and the distribution of vanadium, between the boride layer and the substrate, can be generally considered as uniform (Fig. 3b).

Boron carbide B_4C has been also revealed in the boride layer. This extremely hard and consequently brittle phase, upon preparation of polished sections, flakes off from the boride layer, leaving behind craters (Fig. 4) that are look at low magnifications like pores (Fig. 2).

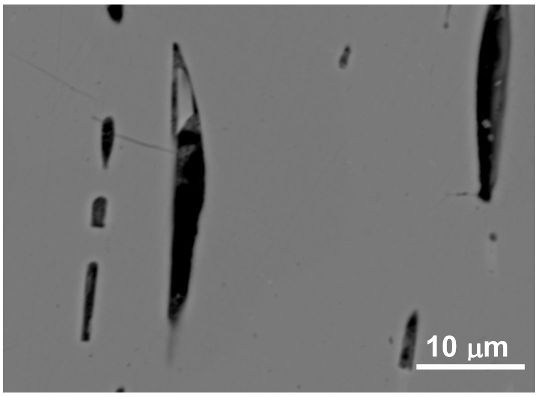

Fig. 4. SEM image of the boron carbide in the bulk of the boride layer

Element mapping images of boron carbide in the bulk of boride layer are shown in Fig. 5. Number of boron carbide seems to be affected by the cooling rate after boronizing being larger in the case when simples have been cooled in still air.

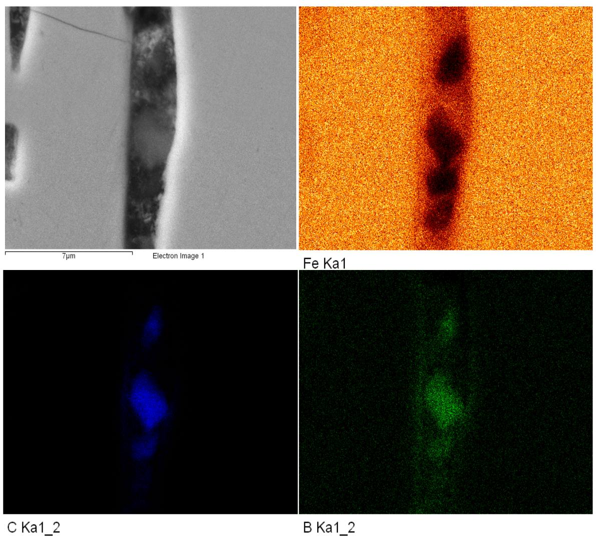

Fig. 5. (a) SEM image and (b - d) elemental mapping images in a cross-section of the boride layer

4. CONCLUSIONS

The results shown here demonstrate that well adhered (diffusion controlled) boride layer formed by Fe_2B has been thermo-chemically developed on the surface of the hot work tool steel. The microhardness of the boride layer is in the range of 1408-1449 HV0.1, while the microhardness of the substrate is 457 HV0.1 in the case of cooling into the furnace and 626 HV0.1 in the case of cooling in still air.

5. ACKNOWLEDGMENT

The financial support of the grant from the Ministry of Education of the Slovak Republic VEGA 1/0383/10 is gratefully acknowledged.

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Reverse logistics processes in plastics supply chains

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Abstract

Logistics systems activities require the assurance of adequate economical and environmental efficiency level on the demand of sustainable development. Reverse logistics – because of the complexity and increasing importance in logistics processes – has become one of the most important areas of the eco-efficiency rise. New system solutions are observed as essential to increase the eco-efficiency level of reverse management. On the paper the economical and environmental optimisation of the reverse logistics processes by using Life Cycle Assessment (LCA) technique in production enterprises will be focused.
This paper aims to highlight the role of reverse logistics in plastic supply chains. The premise is the choice of reverse logistics for plastics on the one hand, consideringtheir versatile applications, such as in the packaging, construction and automotive industries. On the other hand, an extremely important issue is that their production is characterized by high dynamics, has a significant impact on the environment, contributing significantly to the use of the valuable resource that is oil.
The main objective of the cognitive work is the search for a universal tool for quantification and qualification of the environmental benefits generated by the logistics of recovery and recycling of waste plastics.
One of the instruments for the comprehensive assessment of the environmental impact of plastics production, coupled with their recovery and recycling is the ecological balance. The popularity of this tool is shown by the methodology of unification in the global ISO standards 14000x - as art (LCA) Life Cycle Assessment (ISO 14040 and ISO 14044).

Keywords: Logistics; Reverse logistics; Plastics industry; Plastics supply chain.

1. INTRODUCTION

The current thinking about supply chains is focused primarily on logistics flows from raw materials to finished products, therefore those processes which primarily lead to interest in creating and developing supply chains.

The global market, technology improvement and sustainability development has involved new model of supply chain. A new trend in logistics is observed [1], [2], [3]. In recent years, in the context of sustainable resource management, there is a new concept, that of reverse logistics, for which there are synonymous terms such as: reverse logistics, Ecologistics, logistics in the field of recycling, or waste logistics. The problems of waste management are increasingly falling into the field of logistics – this is reflected in the growth of reverse logistics.

Reverse logistics is defined as the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal [4].
Remanufacturing and refurbishing activities also may be included in the definition of reverse logistics. Reverse logistics is more than reusing containers and recycling packaging materials. Redesigning packaging to use less material, or reducing the energy and pollution from transportation are important activities, but they might be better placed in the realm of "green" logistics. If no goods or materials are being sent "backward," the activity probably is not a reverse logistics activity.

Reverse logistics also includes processing returned merchandise due to damage, seasonal inventory, restock, salvage, recalls, and excess inventory. It also includes recycling programs, hazardous material programs, obsolete equipment disposition, and asset recovery [5].

2. THE AIM OF THE RESEARCH

The presented article is a part of research on developing application methods for the settlement of environmental-economic support for reverse logistics processes aimed at reducing consumption of energy and raw materials by plastics manufacturers, which ultimately translates into added value in terms of so-called environmental benefits.

Those objectives meet the assumptions of Integrated Product Policy ((IPP) developed by the European Commission in 2003, whose basic tenet is to think in categories of life cycle (Life Cycle Thinking). The introduction of this principle to business practice requires such an integrated approach to waste management issues and dissemination of the flow of reverse logistics processes.

This assumption has become an inspiration to undertake research on the use of natural resources in a sustainable manner, meaning not only ensuring long-term availability, but also taking into account the environmental effects of their use. At the same time, those effects should be analyzed in a full cycle of processing of resources (at all stages of the value chain) - from the extraction of raw materials and their use as a production factor, through to the processes of transformation in production, to consumption and followed by the logistics process of returning used goods in circulation in economic and/or environmental terms.

It should be stressed that current knowledge on the relationship between resource availability and the implications generated by their use and subsequent recovery is still only partial knowledge, and these relationships are significantly changing under the influence of both technological and social development.

3. VALUE CHAIN OF PLASTICS

Figure 1 shows the lifecycle of plastics – from converter demand to finally recovery and disposal. As it is highlighted the plastic's converter demand is 45 m tonnes, but only little more than half of this currently ends up each year as waste (24.4 m tonnes). 2009 was the first year when the generation of plastics waste fell from the previous year. The drop was smaller than the reduction in plastics demand at 2%. The progress in capturing the value from plastics waste is, on average, slow. The recovery rate increase is approximately +2 percentage point per year. Many EU member states need to make greater efforts, to bring their recovery rate to 80% and more by 2020 [6].

The revised Waste Framework Directive (WFD) provides a framework to drive waste management practices in the EU.

Underpinning this is the recognition of the 5 step waste hierarchy as a priority order to be applied flexibly using life cycle thinking to allow each waste stream to be handled in the best environmental way, considering economic viability and technical feasibility. The hierarchy for improving resource efficiency is (in descending priority order) [6]:

- reduce
- reuse
- recycle
- recover
- disposal

The most resource-efficient approach is not to generate the waste in the first place or to create as little as possible. The next option is reuse (using an article over-and again). If reuse is not feasible then products should be recycled, provided that this is more eco-efficient from a lifecycle perspective than recovery. The last resort is disposal which should be minimised.

4. RECYCLING AND REVERSE LOGISTICS

All plastics can be recycled however the extent to which they are recycled depends upon both economic and logistic factors. As a valuable and finite resource, the optimum use for most plastic after its first use, is to be recycled, preferably into a product that can be recycled again.

Used plastics can be recycled up to six times. If it doesn't make economic or environmental sense to recycle, then the energy can be recovered through Energy from Waste (EfW) incineration. Used plastics have a higher calorific value than coal and at a time of high energy prices unrecyclable materials can, through EfW provide a much needed local energy supply.

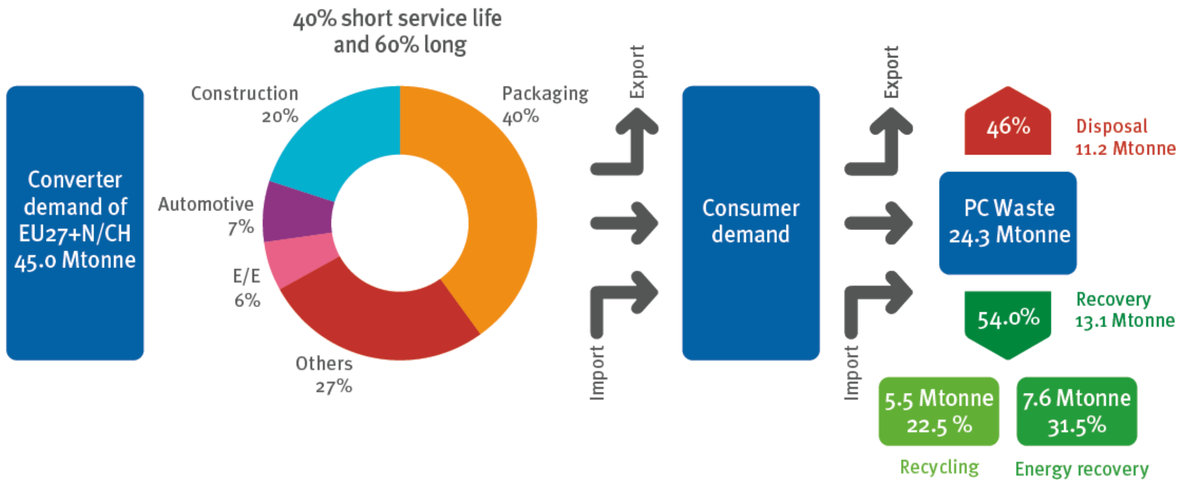

Fig. 1. The value chain of plastics [6]

Table 1. Recycling and energy recovery rate per country.

	Recycling	Energy recovery	Total recovery
Switzerland	24.5%	75.2%	**99.7%**
Germany	33.9%	62.8%	**96.7%**
Denmark	21.2%	75.4%	**96.6%**
Sweden	33.0%	62.9%	**95.9%**
Austria	28.3%	67.4%	**95.7%**
Belgium	29.3%	63.8%	**93.1%**
Netherlands	24.9%	64.3%	**89.2%**
Norway	25.6%	62.7%	**88.3%**
Luxembourg	16.4%	67.6%	**84.0%**
France	16.0%	38.6%	54.6%
Slovakia	21.3%	26.7%	48.0%
Italy	23.0%	21.8%	44.8%
Czechia	29.9%	14.3%	44.2%
Finland	15.7%	26.6%	42.3%
Hungary	18.1%	20.3%	38.4%
Estonia	29.9%	8.2%	38.1%
Spain	20.9%	14.4%	35.3%
Portugal	17.4%	13.9%	31.3%
Ireland	25.0%	4.8%	29.8%
Poland	16.5%	11.3%	27.8%
UK	18.9%	7.4%	26.3%
Slovenia	21.4%	3.3%	24.7%
Latvia	21.6%	1.1%	22.7%
Romania	12.1%	6.5%	18.6%
Lithuania	17.3%	0.0%	17.3%
Bulgaria	12.8%	2.7%	15.5%
Greece	12.1%	0.0%	12.1%
Cyprus	10.7%	0.0%	10.7%
Malta	8.8%	0.0%	8.8%

Source: self study on basis: Borkowski K., Recycling opakowaniowych odpadów tworzyw sztucznych w Polsce, Conferenc materials, Poznań, 2011

Nine countries (table 1) with best recovery results have very strict boundaries to waste disposal. Total or partial embargo to plastic waste disposal there is implemented. Countries with high recovery rates do well on both recycling and energy recovery. A complete resource management strategy needs to address both, as no country will be able to recycle all post-consumer waste.

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5. CONCLUSIONS

LCA techniques adapted to the needs of reverse logistics allow the exploration of the comprehensive environmental impact of plastics in the full life cycle - “from cradle to grave”, including both their manufacture and disposal phases. Despite the relatively complex procedures, methods based on life-cycle analysis are in increasingly widespread use, because the use of computer technology allows the introduction of modelling and simulation, which greatly facilitates the evaluation of several factors simultaneously, and the verification of solutions to multiple variants of multiple repetitions in a relatively short period of time. This reduces the costs of research and supports the decision making process undertaken not only in logistics processes, but also those that are taken at the stage of reverse logistics.

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Modelling of the collaborative manufacturing networks

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Abstract

Collaboration can provide a basis for competitiveness, flexibility and agility in turbulent market conditions. Participation in networks has become the chance to increase a profit, especially for small and medium enterprises (SMEs). In this paper, a concept of rapid prototyping method of the collaborative manufacturing networks is proposed. In practice it allows to plan of the acceptable variants of networks which are able to new production undertaking execution on time, according to logistic constraints (production capacity, transportation, storage capacity, etc).

Keywords: Industrial logistics; Collaborative manufacturing networks; Production undertaking planning; Logistical limits.

1. INTRODUCTION

As a reaction to highly dynamic market challenges, and taking advantage of the facilities offered by the advances in information and communication technologies, today's enterprises are increasingly operating in cooperative networked environments. Nowadays, participation in networks is very important for all organization that strives to achieve a differentiated competitive advantage. Collaboration is a key issue in addressing market demands, particularly in the manufacturing sector, through sharing competencies and resources. Thus, companies, especially small or medium sized, are changing the nature of their modus operandi by partnering with other companies in complex value chains to eliminate waste and lower costs [5].

In today's industry, collaborative networks manifest in large variety of forms. Moving from the classical supply chain format, characterized by relatively stable networks with well defined roles and requiring only minimal coordination and information exchange, more dynamic structures are emerging in industry. Some of these organizational forms are goal-oriented, i.e. focused on single project or business opportunity, such as in the case of virtual organization (VO) [1], [2]. The concept of VO is understood as a temporary consortium of enterprises that strategically join skills and resources, supported by computer networks, to better respond to business opportunity [3].

The creation of long term clusters of industry or service enterprises represents an approach to overcoming these obstacles and can support the rapid formation of VO inspired by business opportunities. The concept of cluster of enterprises, which should not be confused with a VO, represents an association of enterprises and related supporting institutions that have both the potential and the will to cooperate with each other [2], [4].

Problems of modelling of collaborative networks were considered within the ECOLEAD project (European Collaborative Networked Organizations Leadership Initiative) for few last years. ECOLEAD project has led to effective contribution to the establishment of comprehensive reference models for collaborative networks, and thus to offer the basis for researchers interested in the field [1].

One of the main considered problems is selection of partners for dynamic collaborative manufacturing network. To solve that and modelling virtual organizations, optimization and simulation methods are often chosen which are very time-consuming and work consuming [8]. It doesn't allow to set acceptable solutions in "on-line" mode. Thus, one should do research to create and implement methods and computer systems which can quickly set acceptable variants of planned collaborative manufacturing network with consideration to capabilities and logistic constraints. Thus, in this paper is suggested a concept of methodology of collaborative manufacturing networks prototyping based on procedure of checking of sufficient conditions.

2. VO BREEDING ENVIRONMENT (VBE)

Any collaboration requires a base level of trust among the organizations. Therefore, some researchers with practical perspective focus on idea of a VO breeding environment (VBE) for dynamic formation of Virtual Organizations (VO) [1], [2]. This concept has emerged as the necessary context for the effective creation of dynamic virtual networks especially in manufacturing sector in works [4], [6]. In considered case VO Breeding Environment (VBE) is understood as an association of organizations, adhering to the base of long term cooperation agreement and adoption of common operating principles and infrastructures, with the main goal of increasing their preparedness towards rapid configuration of temporary alliances for collaboration in potential virtual organizations (e.g. virtual collaborative manufacturing networks - VCMN) [2].

In this paper an idea VBE can be identified with modus operandi of cluster of enterprises. The concept of cluster is often characterized by the geographical closeness, cultural ties, the same industrial branch (e.g. metal branch), even particular human relationships which are also motivating factors in building trust between partners. The clusters can support the exploitation of local competencies and resources by an agile and fast configuration of set of partners for each business opportunity (e.g. new production undertaking). Therefore, in times of competition and market turbulence, clusters may offer the opportunity to share experiences and costs in the learning process of introducing new information and communications technology for instance, within an industry cluster, and to reduce the risk of losses and failure. [1].

2.1. Model of virtual collaborative manufacturing network

In considered case, the virtual collaborative manufacturing network (VCMN) is understood as a temporary subset of production enterprises and related supporting institutions of cluster, which together are able to execute new production undertaking (production orders) on time with the assumed costs, supported by computer network.

In order to support rapid formation of collaborative networks, as a basic rule, it is necessary that potential partners are ready and prepared to participate in such collaboration. This readiness includes common interoperable infrastructure, common operating rules and common cooperation agreement, among others. Any collaboration also requires the base level of trust [2]. On the other hand, these enterprises are characterized by following limitations: production capacity (a kind of operations, time of availability, cost of using production resources), transportation routes, means of transport (quantity, capacity, time and cost of drive) and capacity of storehouses. Thus, forming the new virtual manufacturing network within the cluster is not easy.

The very important component of the presented model is one of the members of cluster, acting as a broker. The main goal activity of this broker is to identify business opportunity and connect cooperating companies, which would be able to execute production order with known limitations. The broker has to organize a temporary network of enterprises which guarantees that production undertaking execution is on time and with as low as possible realization costs.

The new production undertaking is specified by the size of planned production, given time of execution and costs of realization (price). The way of production order realization is described by production (technological) process $Pz = (O_1, O_2, \ldots, O_i)$, marked as a vector. The elements of this vector are characterized by partial operations which are executed in various enterprises. Execution of this undertaking often exceeds the potential of single enterprise, according to its production capacity and possessed technology. In this case, rapid forming a collaborative network is necessary.

2.2. Problem of modelling of VCMN

In this paper the following research problem is considered: *is there a virtual collaborative manufacturing network (VCMN) of enterprises which can execute production undertaking on time with the assumed costs?* The main goal of research is to propose a methodology of rapid prototyping of VCMN.

3. THE METHODOLOGY OF MODELLING OF VCMN

The prototyping of virtual collaborative manufacturing networks (VCMNs) based on selection such enterprises of cluster which have production capacity and allow for production orders execution. The important instrument of suggested conception of prototyping is a production capacity exchange platform, which can use one of the member of cluster, acting as a broker. The broker supported by suitable computer system can select such enterprises which guarantee execution of production undertaking and create virtual manufacturing network.

The presented methodology consists of three stages. In the first stage a set of acceptable variants of network (space of acceptable solutions) PDRI is formed, which meets the requirements of operation kind. The initial space of potential solutions can be set according to formula 1.

$$PDR_I = \prod_{i=1}^{m} e_{p_i}, \qquad (1)$$

where:

epi - quantity of enterprises which are able to execute i-operation according to operation kind (for example assembly); m - quantity of operations in process.

A set PDR_I is limited on the basis of checking of sequence of sufficient conditions (algebraic-logical conditions). In this stage production capacity (machines, workstation, etc.) of each enterprise and sequence of operations are checked. For instance, fulfilling two next sufficient conditions (2) and (3) denote availability of capability i-resource of enterprise which would like to participate in the network. In this stage enterprises, which don't have enough capability in required time or don't assure sequence of operations, are rejected. The set is limited to a set PDR_{II}.

$$\text{i)}\ \forall M^i_{w,n+1},\ \exists k \in \{1,\dots,T\},\ u_{M^i_{w,n+1,k}} = O \qquad (2)$$

$$\text{ii)}\ \forall M^i_{w,n+1}, \exists t^o_i \in \{1,\dots,T\}, \forall k \in \langle t^o_i,\dots,t^o_i + cz_{w,n+1})\rangle,\ u_{M^i_{w,n=1,k}} = 0 \qquad (3)$$

where:

$M^i_{w,n+1,k}$ - i-resorce of enterprise suitable for operations of production undertaking P_{n+1};

$u_{M^i_{w,n+1,k}}$ - element of k-column and i-line of matrix of resources capability. Lines describe every resource of enterprises that can be used in execution of new production undertaking P_{n+1};

t^o_i - moment of stoppage of i-resource;

O - resource is idle;

$cz_{w,n+1}$ - required realization time of operation of P_{n+1}.

In the second stage, a set of variants is limited to such ones, which fulfill conditions connected with transportation and storage systems. Each variant is checked according to available route structure, quantity and capacity of transportation means and storehouse capacity of co-operators. In proposed approach transportation system realizes operations of transferring material between enterprises according to the established schedule. Transportation means with known capacity move along given routes of connected participants of logistic network. The schedule is established on the basis of offers of forwarding enterprises which guarantees availability of transportation means with given capacity in a length of time in given section of route. It allows for quick and credible assessment of possibility of transportation operations execution, without time-consuming and cost-consuming planning of transportation timetable.

Using of the suggested solution guarantees possibility of finding acceptable solutions, if such are. As a result of that, there are acceptable variants of network (PDR_{III}) with variants of transportation-storage support which guarantees production order execution on time.

In the third stage of suggested methodology, planned cost of production order execution is calculated. It is determined by a set of PDR_{IV} solutions, which guarantees production order execution on time. The costs of production order execution are divided into some groups of costs like: material costs, individual operation costs of each manufacturing enterprises which participate in the network, transportation costs between partners, insurance costs, storehouses costs and costs of administration and management (including cost of broker service).

In considered approach all variants, which guarantee production order execution on time, are distinguished ($PDR_{IV} \subseteq PDR_{III} \subseteq PDR_{II} \subseteq PDR_{I}$). The information about costs allow for selection of the cheapest variant of cooperating network. When a set of solutions is empty, the proposed methodology rejects planned production undertaking (order) and informs about reasons of rejecting.

4. CONCLUSIONS

The most important problem of forming virtual production network is lack of methods and computer systems, which would allow for quick and credible specifying of new possibilities of production undertaking realization. The proposed methodology based on propagation of constraints of cooperating enterprises allows selecting co-operators that are able to execute production processes in a network, and assume possibility of planned production order, to realize them in conditions of transportation systems and storage constraints.

The further research concentrates on describing technological operations and logistic operations (transport, storage) of potential co-operators and also on working out of computer exchange production capacity platform. This platform will allow for quick prototyping of VCMN.

5. ACKNOWLEDGEMENTS

This paper contains current results of the project “Modelling of virtual production networks of SME’s”. The project is financed by National Science Centre (Poland) on the base of agreement no. 4039/B/H03/2011/40.

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CAM strategies at machining

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Abstract

Paper focuses on the precision of components produced by CAM strategies. On the present almost all sector of industry are founded on the development of new products and CAD technologies, engineering calculations and software simulations CAE and production management CAM, by the help of computers. Today by the computer support are designed all resources and technologies for the component producing, their measuring, control and creates bigger requirements for the precision of products, quality and of course, price. This paper deals with the influence of CAM finishing strategies for the shape and dimension accuracy of surfaces.

Keywords: CAM strategies; Finishing; CAD/CAM systems; Milling; Surface.

1. INTRODUCTION

Nowadays, there is a growing tendency of rivalisation among industrial companies, which requires more efficient production. At the same time custumers have more strict, quality-based requirements towards manufacturers. CNC controlled machine tools and CAM softwares raise the efficiency of the production of workpieces machined with cutting. Market competition among CAM software dealer companies can be experienced.

With these softwares it is possible to machine complex, non-analytical surfaces in an accurate and rapid way. These workpieces can be used in several industries. We can often meet with freeform surfaces, for instance profile or molding tools.

Using of CAD/CAM systems has several advantages. Built surfaces and toolpathes are handled flexibly, moreover it can be varied and monitored by softwares easily [1].

2. CAM STRATEGIES AT FINISHING

CAM sotfwares offers many finishing strategies for the producing of 3D surfaces, for the achieving of better surface roughness and shape accuracy. But, the toolpaths, designed by computer softwares, are not able to achieve perfectly during the production, by spherical, or cylindrical milling tool.

This follows from fact, that the tool path during machining consists from line segments. The machining precision affects several parameters.

The two most important parameters are the following:

- difference between the theoretical and the actual tool path (string mistake),
- imperfections due to the tool trace.

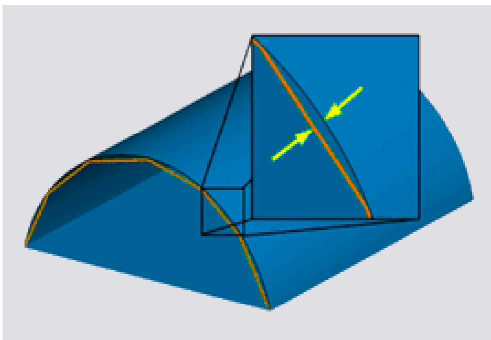

Fig. 1. Difference between the theoretical and the actual tool path [1].

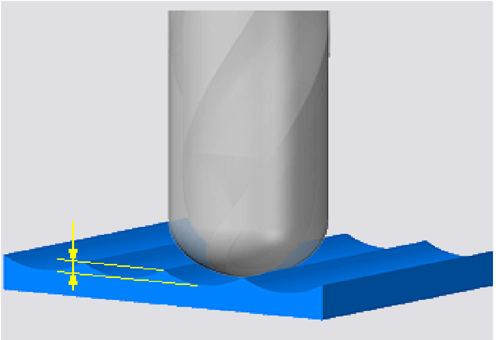

Fig. 2. Imperfections due to the tool trace [1].

Now-known 3D and 5D finishing milling strategies are the following [5]:

- **Milling by the projection.** The movement of a milling machine is pre-defined in the XY plain and subsequently it is projected onto a model.

Pre-defined 2D paths in the XY plain can have these shapes:

- **spiral** (fig. 3)

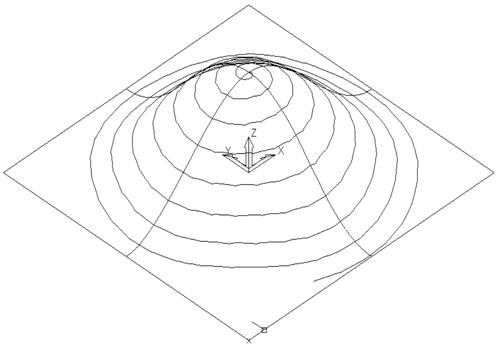

Fig. 3. Movement after spiral [5]

- **radial shape** (fig. 4)

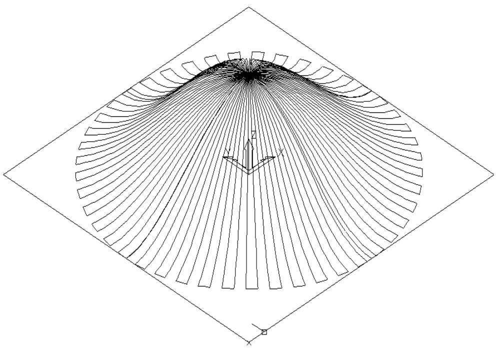

Fig. 4. Movement after radial [5]

- **offset** (fig. 5),

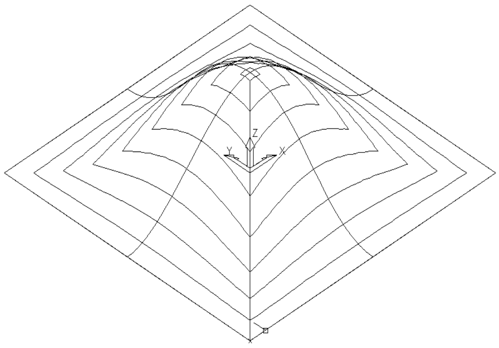

Fig. 5. Movement after rectangles [5]

- **raster** (fig. 6).

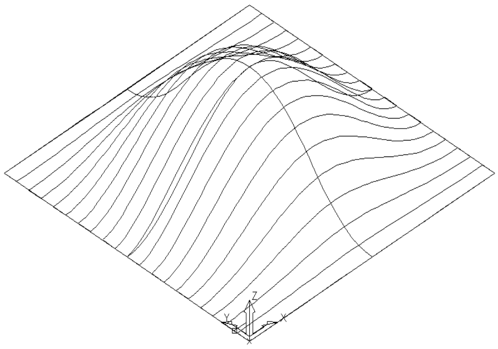

Fig. 6. Strategy Raster decrescented to the centre

3. METHODS AND MATERIALS USED FOR RESEARCH

In this topic you can find the machining conditions. In experiment I dealed with the machining of composite material with constant CAM strategy and various cutting conditions (f_z).

Machining of composite materials is difficult to carry out due to the anisotropic and non-homogeneous structure of composites and to the high abrasiveness of their reinforcing constituents. This typically results in damage being introduced into the workpiece and in very rapid wear development in the cutting tool [2].

At experiment I used material GPO3 - fiberglass reinforced polymer laminate. This material is the industry standard for flame & arc/track resistant electrical components. GP03 also offers an excellent combination of high strength, flame resistance, and low smoke, flame, & toxicity generation [3].

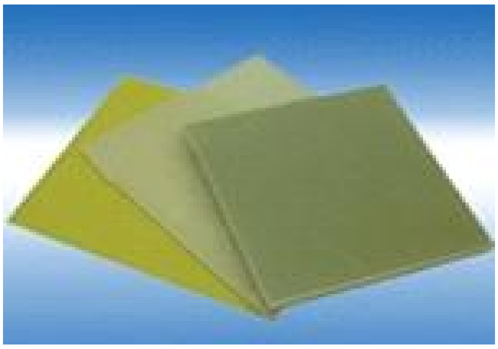

Fig. 7. Composite GPO 3 [3]

I realized the experiment on the 5D CNC machining center NCT EmL-850D (Fig. 8), as workpiece I used material with mark GPO3 and as device I used chuck.

The workpiece has size 80x80 mm. At roughing I used roughing cutter JC860, which you can see on Fig. 9. The cutting parameters for roughing you can see in Table 1.

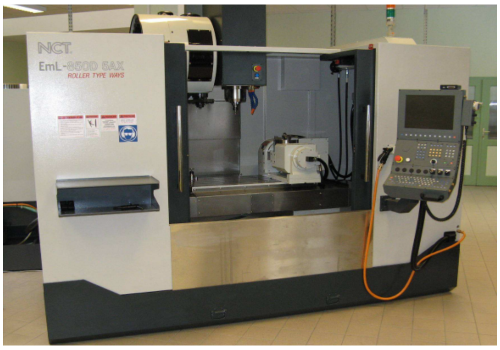

Fig. 8. NCT EmL-850D machining centre

Fig. 9. Tool for roughing [4]

Table 1. Cutting parameters at roughing

V_c [m.min^{-1}]	f_z [mm/tooth]	a_p [mm]	a_e [mm]	n [min^{-1}]
50	0,016	4	8	1990

At finishing I used the ballnoise end mill JC850, which you can see on Fig. 10. Cutting parameters for finishing are in Table 2.

Fig. 10. Tool for finishing [4]

Table 2. Cutting parameters at finishing

V_c [m.min^{-1}]	f_z [mm/tooth]	a_p [mm]	a_e [mm]	n [min^{-1}]
50	0,1/0,3	0,3	0,3	1990

This research focused on investigation of the effect of constant CAM strategy on the roughness of cylindrical surface. This strategy was used at constant material and constant tool, at variable technological parameters.

I used CAM software Mastercam X5. At selecting of strategy I considered the diversity of avaliable strategies and the published developments.

On the base of these facts, the selected strategy was SPIRAL, one from the Mastercam X5 Surface High Speed Toolpaths. I used the „3D Toolpath Refinement, what is avaliable at this strategy.

You can see the workpiece on Fig. 11.

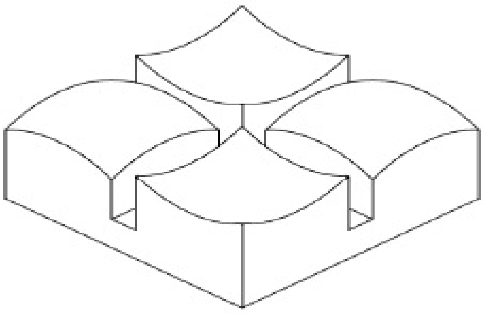

Fig. 11. Workpiece

We measured the following parameters on the workpiece: Ra, Rz, Rq, Rt. On paper we focused on the Ra. We measured the roughness with Mitutoyo Formtracer SV-C3100 Contour and surface roughness measuring machine, what you can see on Fig. 12.

Fig. 12. Mitutoyo Formtracer SV-C3100

On Fig. 13 you can see the machined workpiece.

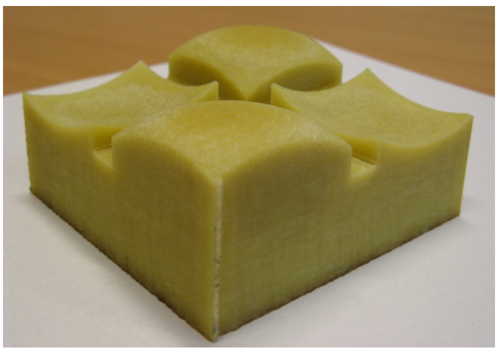

Fig. 13. Machined workpiece

The roughness measurement of workpiece was follows: workpiece is from four separate parts, every part I deviced for three fields.

The deviced surface is on Fig. 14.

I measured the surface roughness on these three parts, on part A, B, and C. The obtained values are shown in Table 3 and 4.

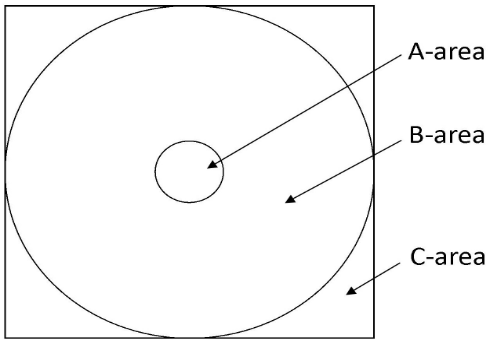

Fig. 14. The allocation of workpiece

Table 3.. Roughness at f_z=0,3 mm

concave			convex		
A	B	C	A	B	C
R_a [μm]					
3,20	4,41	6,05	3,21	3,36	5,39

Table 4. Roughness at f_z=0,1 mm

concave			convex		
A	B	C	A	B	C
R_a [μm]					
3,40	3,50	4,21	3,01	3,50	3,66

On Fig. 15-17 you can find the evaluation of the measurements in zone A, B and C. The blue trend line indicates the convex surface, the red trend line indicates the concave surface.

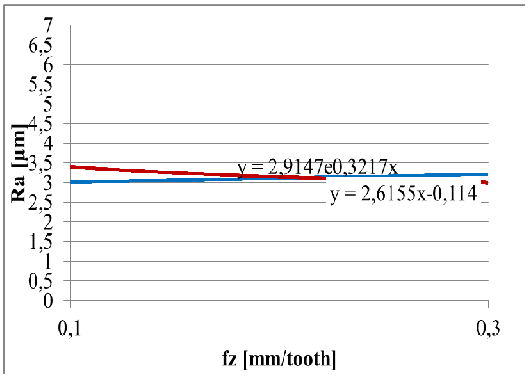

Fig. 15. The feed-reducing effect of the convex and concave surfaces of the surface in A-zone

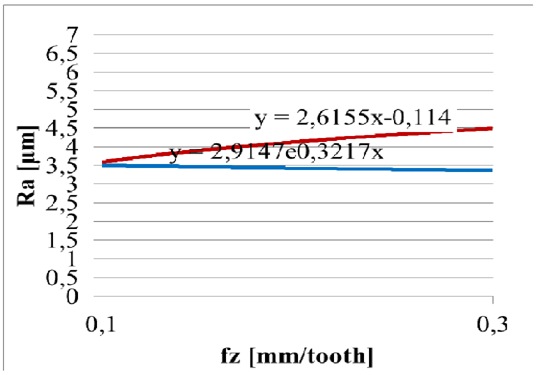

Fig. 16. The feed-reducing effect of the convex and concave surfaces of the surface in B-zone

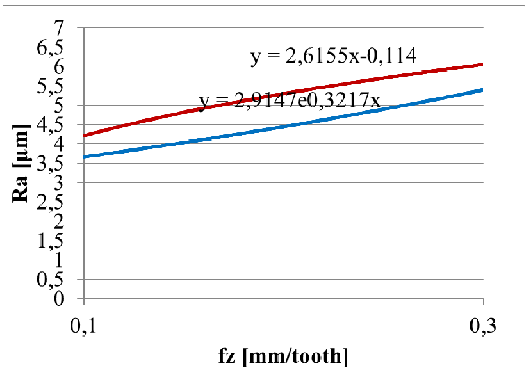

Fig. 17. The feed-reducing effect of the convex and concave surfaces of the surface in C-zone

4. CONCLUSIONS

As the graph on Fig. 15. shows, in zone A, decreasing of f_z have a negative effect on the roughness of concave surface.

In zone B, decreasing of f_z have a positive effect on the roughness of concave surface.

This positve effect also applies at zone C, at concave and convex surface, too.

In zone B, decreasing of f_z at convex surface forms a negative effect.

The increasing roughness at zone A at concave surface and at zone B at convex surface,too can explained with fact, that the tool does not cut off the strings completely. It is also, because the v_c in these zones is near to zero.

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Quality Assessment of Titanium-Copper Joints Prepared by Explosion Welding

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Abstract

The paper describes the results of research of Ti-Cu joints made by explosion welding. It concerns bimetallic targets for sputtering process in microelectronics, where one of the metals (Ti) is of high purity. Described are the materials frequently used for target fabrication and technologies often used for the production. Included are also brief characteristics of the welded materials, their mechanical and other properties as well as need for their purity. A key part of the paper is devoted to the explosion welding process, its description, including the welding parameters, used explosives and welding procedure itself. The quality control was carried out by optical microscopy, micro hardness measurements and X-ray microanalysis of joint interface.

Keywords: Explosion welding; Bimetal; Copper; Titanium; Metallographic analysis; EDX microanalysis; Thermo calc.

1. INTRODUCTION

The presented article discusses the highly topical theme of large-scale explosion welding of combined metals. This issue is particularly topical in terms of joining metals with very different physico-chemical and mechanical properties. It is a combination of metals that can not be fusion welded by traditional or by special hot melt technology, including lasers.

The knowledge gained from the literature suggests that, during the selection of appropriate technology of metallurgical bonding of combined metals (manufacture of targets for sputtering), special attention is to be given to keeping the required purity of deposited metal [1]. A number of alternative technologies of welding in the solid state were selected, with their welding parameters and geometric dimensions of welded materials. It turned out that the explosion welding is the most suitable technology for producing larger bimetals.

2. METHODS AND MATERIALS USED FOR RESEARCH

2.1. Welded materials

Materials selected for welding were high purity titanium and technically pure copper. Dimensions and several selected properties of welded metals are in Table 1.

2.2. Explosion welding process

In this case, explosion welding is the production technology of such bimetals. The principle of this technology is well known.

Two forms of materials arrangement are known in this welding technology, oblique and parallel arrangement.

In this case, parallel arrangement was used. It is characteristic by expression $\alpha = 0$, $v_k = v_d$ and $\beta = \delta$ (Fig. 1). Welded materials are usually situated in parallel using distance pins in a defined mutual distance needed for acceleration of plating material to the final flying speed. Explosive charge, usually of loose consistency, is placed in a wooden or similar frame attached to accelerated material.

Table 1. Dimensions and properties of welded materials

Base metal	Metal	Titanium, Ti 99.9999
	Dimensions [mm]	Ø366x14
	Density [$g.cm^{-3}$]	4.5
	Melting point [°C]	1668
	Coefficient of thermal expansion [K^{-1}]	8.4×10^{-6}
Flying metal	Metal	Cupper, Cu 99.95
	Dimensions [mm]	400x400x4
	Density [$g.cm^{-3}$]	8.9
	Melting point [°C]	1083
	Coefficient of thermal expansion [K^{-1}]	17.7×10^{-6}

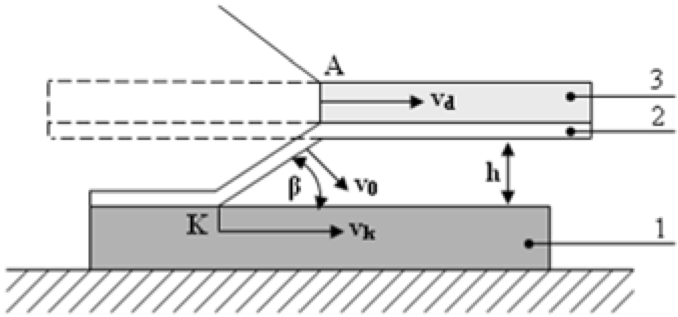


Fig. 1. Parallel way of assembly of welded materials [2]
1 – base metal, 2 – flying metal, 3 – explosive, h – distance, K- point of collision, v_k – collision velocity, v_d - detonation velocity, v_0 – accelerated to plate velocity, β -dynamic band angle

Welded joints made by explosions are characterized by wavy interface (edge). The most important parameters of explosion welding include [2]: detonation velocity - v_d, accelerated to plate velocity - v_0, collision velocity - v_k, distance between the welded materials – h.

Based on theoretical knowledge and practical experience, welding parameters and conditions have been established for each combination of welded metals.

2.3. Bimetal examination

The first test was visual inspection focused on observing any surface disintegrity of the bimetal. The bimetal did not show any defects even at its edges. This was followed by ultrasonic testing directed to potential defects in bimetal interface [3], optical microscopy and X-ray micro analysis examination oriented to analysis of intermetallic phase in weld joint interface after heat treatment and microhardness measurements aimed to working hardness intensity in weld joint interface.

3. RESULTS AND ACHIEVEMENTS

3.1. Optical microscopy

Images with microstructure of weld joint (Fig. 2) show the structure of welded materials and deformation-affected weld interface areas. Due to high pressure generated in the welding process, the structure of Cu was intensively deformed. More than 60% of polygonal Cu grains are deformed. Also, it is possible to observe mechanical mixing of Cu and Ti, so called islets, in the interface area. These islands occur with some regularity along the weld joint interface in the spreading direction of the detonation wave front. They, however, do not form a continuous layer. It is assumed that this is mechanical mixing of Ti and Cu. Also, the

IMF, or amorphous state, is likely to occur in these islands.

3.2. X-ray micro analysis

EDX microanalysis was used for a more detailed assessment of bimetal weld joint interface. In the evaluation, spot and line microanalysis, and map of elements distribution was carried out. Based on the results of this analysis, the presence of IMF can be assumed. Areas with the content of both welded metals can be observed here. In the case of combination of Cu-Ti, several phases can occur, such as stoichiometric intermetallic phases Cu_3Ti_2, Cu_4Ti_3 and $CuTi_2$ and non-stoichiometric intermetallic phases CuTi and Cu_4Ti. This is documented by Cu-Ti binary diagram.

To assess changes in structural state of the interface of weld joints, where also the IMF occurrence was predicted and where their growth is expected due to heat exposure of weld joint, thermal processing of Cu-Ti bimetal was made. Based on the results of EDX microanalysis of the samples after heat treatment, dependency of the molar proportion of phases present in the bimetal on temperature was investigated, using Thermo Calc software calculations. These results were then plotted in charts. At linescan measurement of specific elements through the joint interface, it was found that changes in concentrations of these elements are not continuous, but they are in few steps (jumps). This confirms the presence of several transition layers. E.g. in the case of Cu-Ti joint, after heat exposure at 800°C / 24 hrs, (Fig. 3) there were three transition layers identified, which, according to calculation, should have following phase composition: Cu_3Ti_2+Cu_4Ti_3, CuTi, and Cu_3Ti_2+Cu_4Ti.

For explicit identification of IMF, the TEM on thin metal foils along with electron diffraction should be done. It is supposed that this identification could be also done using the EBSD (Electron Backscatter Diffraction.).

3.3. Microhardness measurements

Another type of measurement, which could also confirm the occurrence of IMF in the weld joint interface, is microhardness measurement.

These measurements were made perpendicular to the weld interface. The measured microhardness values showed an increase towards the interface of the weld joint. It is assumed that this increase in microhardness values was mainly caused by deformation hardening at the interface of weld joint.

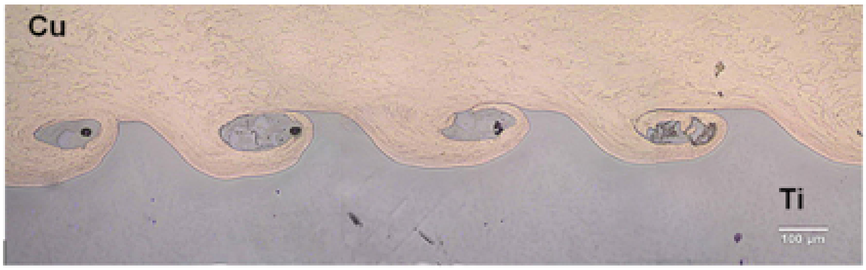
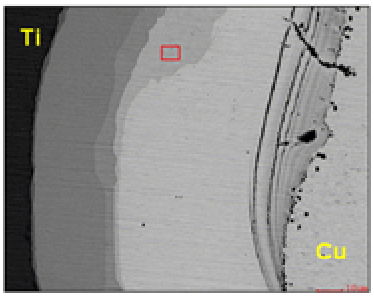


Fig. 2. Microstructure of Cu - Ti bimetal with characteristic wavy pattern



Element	Wt%	At%
TiK	19.12	23.87
CuK	80.88	76.13

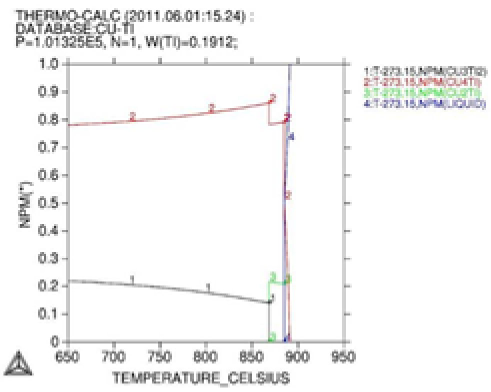


Fig. 3. EDX spot microanalysis results of a numerical indication of the place, and the calculated graph of the molar proportion of phases present on the temperature (800° C / 24 h)

Microhardness was also measured in areas of newly formed islets. These were characterized by significantly higher values of microhardness. As mentioned earlier, there is probability of IMF occurrence in these areas, which would correspond to these values of the microhardness.

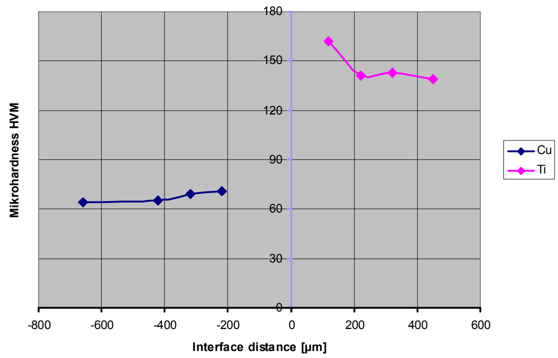


Fig. 4. Microstructure of Cu - Ti bimetal with characteristic wavy pattern

4. CONCLUSIONS

The experiments proved the possibility to produce high quality weld joint between titanium and copper by explosion welding. The above results may be used as a base for detailed analysis of the IMF formation kinetics on the interface of Cu-Ti bimetals, created by the explosion and after heat exposure. It would be necessary to measure thickness of individual transition layers generated at different temperatures and times of heat exposure and use appropriate software for analysis of diffusion processes, for example DICTRA software, which is an extension of Thermo-Calc software, which was used in the work. Then, it would be possible to create a complete model for the analysis of formation and growth of IMF layers at the interface of these materials under various conditions of heat exposure.

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Explosion Welding of Large Area Ti - Al Targets

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Abstract

The paper deals with explosion welding of titanium and aluminum in order to produce bimetals suitable for making targets used in sputtering process. Paper describes the welding parameters and fabricated bimetals, and evaluates their quality. The last part of the paper deals with the quality control examination of final bimetal, i. e. ultrasonic testing, mechanical testing and microstructure analysis.

Keywords: Explosion welding; Bimetal; Aluminium; Titanium; Metallographic analysis; EDX microanalysis.

1. INTRODUCTION

The important part of material production is high purity materials and the procedures of their production. There is a wide spectrum of such metallic and non metallic materials with different areas of application.

Increased demand for thin layer coatings leads to intensification of research focused on different methods of thin layer deposition. There is no universal method of layer production and none of them solves all problems associated with thin layer production. However, the attention is concentrated on sputtering process at a moment. This process belongs to the most versatile ones and fulfils many demands imposed on thin layer production processes.

A key part in sputtering process is a target, made of high purity material. The targets are frequently used as components for semiconductor production and microelectronics. Beside this, they are also used for production of special coatings [1, 2].

Due to the fact that they use high purity materials, their cost is extremely high. In order to lower the cost, there is possibility to manufacture them as bimetals. This paper describes the possibilities of producing bimetal targets by explosion welding.

2. METHODS AND MATERIALS USED FOR RESEARCH

2.1. Welded materials

Materials selected for welding were high purity titanium and technically pure aluminium. Dimensions and several selected properties of welded metals are shown in Table 1.

2.2. Explosion welding process

In order to join 100% of base material surface, the flying material has to overlap the base one. The overlap dimensions approximately equal to the charge thickness, in our case the 18 mm overlap was chosen.

Surfaces of materials to be welded were ground and consecutively degreased by acetone. The parallel set-up of welding materials was chosen with titanium as backer material and aluminium as flying one. Welded materials are usually situated in parallel using distance-pins in a defined mutual distance required for acceleration of plating material to the final flying speed. Explosive charge, usually of loose consistency is placed in a wooden or other frame, connected with accelerated material [1,4] (Fig. 1).

Table 1. Dimensions and properties of welded materials

Base metal	Metal	Titanium, Ti 99,9995
	Dimensions [mm]	Ø366x14
	Density [g.cm^{-3}]	4.5
	Melting point [°C]	1668
	Coefficient of thermal expansion [K^{-1}]	8.4×10^{-6}
Flying metal	Metal	Aluminum, Al 99.95
	Dimensions [mm]	400x400x4
	Density [g.cm^{-3}]	2,7
	Melting point [°C]	658
	Coefficient of thermal expansion [K^{-1}]	$24{,}9\times10^{-6}$

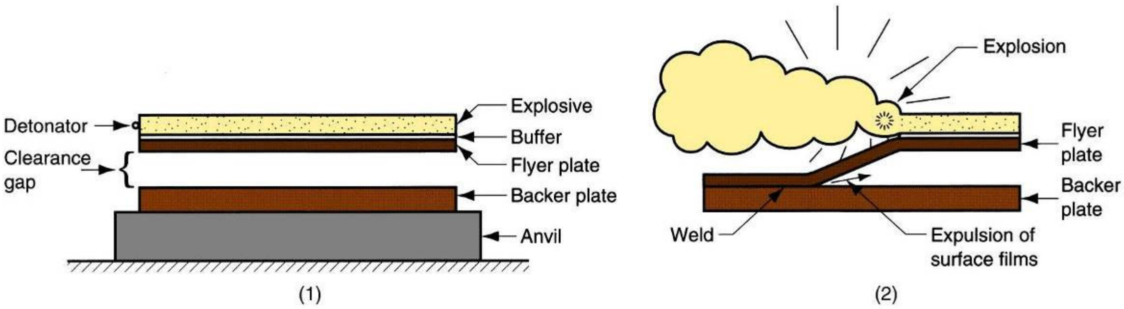

Fig. 1. Parallel way of assembly of welded materials [4]
1) parallel situation of materials, 2) welding process

2.3. Bimetal examination

There were several methods of bimetal inspection used in order to accomplish its complex examination. The first test was visual inspection focused on observing any surface disintegrity of the bimetal. The bimetal did not show any defects, even at its edges. This was followed by ultrasonic testing directed to potential defects in bimetal interface [3], mechanical tests of bimetal strength, optical microscopy examination oriented to micro cracks and melted zones in weld joint interface, and microhardness measurements aimed on working hardness intensity in weld joint interface.

Fig. 2. Specimens after tensile test

3. RESULTS AND ACHIEVEMENTS

3.1. Mechanical tests

In order to examine the mechanical properties of the bimetal there cup-shaped specimens were prepared and subject to a tensile test. All specimens broke out of the weld interface (in aluminium part of the bimetal) and proved quality of the weld joint (Fig. 2).

3.2. Optical microscopy

The optical microscopy did not reveal any micro cracks and defects in weld joint interface. The interface had periodic wavy pattern. There were also isolated islands (Fig. 5) observed in the upper parts of the waves that arose due to turbulence circulation of jet during wavy pattern formation. The grain of both materials near the weld boundary had significantly prolonged shape – typical for explosion welded joints (Fig. 4).

3.3. Microhardness measurements

The analogy of heat affected zone typical for fusion welds is a local plastic deformation near the weld boundary of explosion welded joints (if the welding parameters were designed correctly), and it can be estimated by microhardness measurements. Otherwise the continuous zone of melted materials can be observed near the weld joint boundary and it could be responsible for fragility of weld joint, if the metals are prone to intermediate phase formation. Microhardness measurements proved presence brittle phases in weld joint and also presence of continuous melted zone. The isolated island had maximal microhardness of 484 HV, average microhardness of copper and titanium was 46 HV and 181 HV respectively. The microhardness measurement perpendicular to weld interface is shown in Fig. 3.

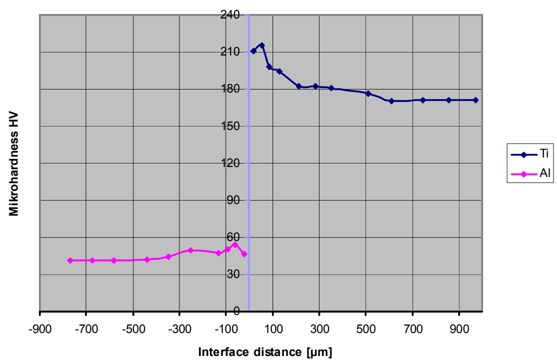

Fig. 3. Microstructure of Cu - Ti bimetal with characteristic wavy pattern

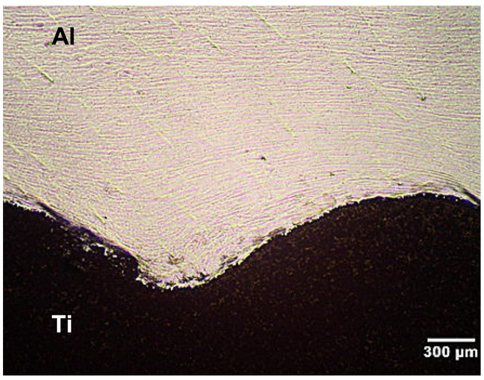

Fig. 4. Microstructure of Cu - Ti bimetal with characteristic wavy pattern

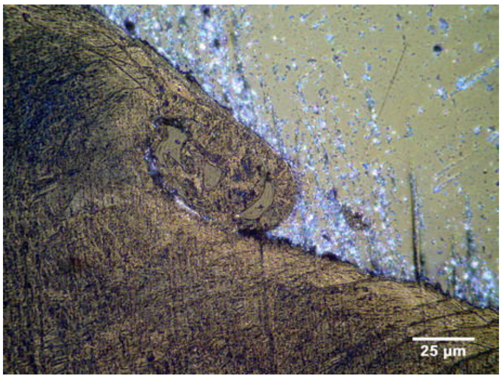

Fig. 5. Detail of isolated island

3.4. X-ray micro analysis

Based on EDX microanalysis and informatively determined concentrations of Al and Ti for individual possible phases across the Al-Ti interface and the subsequent comparison with the binary Al-Ti diagram (Fig. 6) [5], presence of IMF Al_3Ti and $TiAl+Ti_3Al$ compound can be assumed. Analysis of all the weld joint revealed several such spots that may contain these phases. Increased occurrence of such spots can be assumed with increasing welding parameters, which is related to the amount of energy supplied to the weld joint. Clear identification of the IMF presence would require TEM on thin metal foils with added electron diffraction.

The bar-analysis, which was carried out on the island and in Al-Ti interface as well, enables to characterize the qualitative change in the composition of Al and Ti. According to the curve of bar profiles, it can be assumed that there are no defects at Al-Ti interface and that the material is sufficiently mixed.

Sufficient mixing and binding of elements has been possible be also traced in the image of area distribution of Al and Ti at the part of Al-Ti interface, where the EDX - surface distribution of elements was performed.

4. CONCLUSIONS

The experiments proved the possibility to produce high quality weld joint between titanium and aluminium by explosion welding. The joint was crack free, had excellent mechanical properties and the microhardness growth near joint interface was mild. It is not recommended to further increase welding parameters due to the possibility of melting zone formation and risk of creating the intermetallic phase.

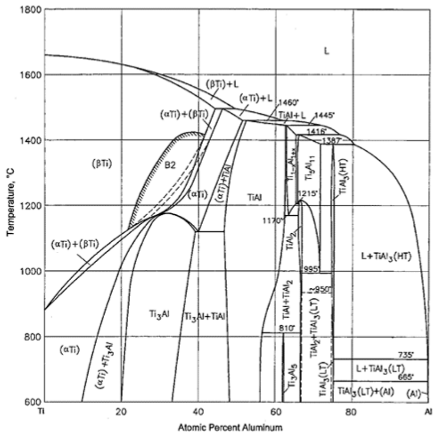

Fig. 6. Al-Ti binary phase diagram [4]

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Analysis of the Influence of Nitrogen in the Shielding Gas in Laser Welding of SAF 2205 Duplex Stainless Steel

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Abstract

In the present paper we describe weldability of duplex stainless steel type SAF 2205 with laser beam welding. The aim of this contribution is to present the results of testing shielding gas by welding duplex stainless steel with laser beam. Major factor in the process of welding duplex steel, is the impact of shielding atmosphere, which affects a large proportion of properties of welded joints in terms of structural components of ferrite/austenite and corrosion resistance. This fact is used in welding the laser beam to achieve an appropriate ratio of structural components of the atmosphere affects trade. Especially as nitrogen element in the process of welding is very important, because more nitrogen promotes austenite. Welding was performed on Gas CO_2 laser machine Ferranti Photonics AF 8 with max. output 8 kW and wave length 10.6 µm. Samples were analyzed in terms of microstructure; we examined the mechanical properties, hardness of welded joints and the proportion of structural components ferrite/austenite in the weld metal. We supposed that the nitrogen as shielding gas could affect to the temperature at which the austenite begins to form from the ferrite, it has resulting in change of volume proportion phase in the weld metal.

Keywords: Duplex stainless steel; Laser welding; Shielding gases; Ferrite/austenite proportion.

1. INTRODUCTION

Duplex steels, together with austenite, ferrite, martenzite and precipitation-hardened steels form a group of stainless steels. The whole group of stainless steels is characterized by their monostructure, while duplex steels are the only members of the group which have a biphase structure composed of ferrite and austenite in approximately the same amounts. A balanced ferrite-austenite ratio is ensured by the use of basic alloying elements (chrome and nickel) and other alloying elements (nitrogen, molybdenum, copper, silicon and tungsten). Together with the chemical composition, the heat treatment regime, i.e. the rate of cooling in the first place, plays an important role in obtaining the required structure. Such microstructure contributes to good properties of these steels, thus making them superior to other stainless steels and steels from other groups for certain applications. Duplex steels rank highly primarily due to their good combination of mechanical properties and excellent corrosion resistance. Therefore, they have found a wide field of application in the petrochemical, food, chemical, pulp and paper, petroleum, and transport industries and in tanker building. Standard austenite stainless steels are being replaced by duplex steels in various steel structures [1, 2].

2. EXPERIMENTAL INVESTIGATIONS

2.1. Tested material and experimental procedure

All experiments were performed with material in form of a seamless tube without final forming and surface heat treatment, made of duplex steel type SANDVIK SAF 2205 with dimensions Ø 42 x 2,7 x 200 (mm). The chemical composition and mechanical properties of the used steel are given in Tables 1 and 2.

Welding tests were carried out by producing beads on the tubes. The tubes were clamped in flat position and welds were performed in a single pass using a 4 kW transverse flow CO_2 laser. A 20 $l.min^{-1}$ flow of N_2 was used as shielding gas. In a first phase of the investigation, a factorial plan was carried out in order to optimise welding parameters in terms of metallurgical and geometrical characteristics of the beads.

The absence of relevant welding defects such as solidification cracks or porosity and a regular shape with full penetration of the weld bead were considered as reference parameters. Welding speed and focus height (distance of laser beam focus from material surface, positive if over the surface) were selected as factors, while the laser power was kept constant at 4 kW. Outer surface at welding was protected by N_2 (He) gas and the root was shielded with N_2 (He). Laser parameters used at welding are given in Table 3.

Transverse to weld samples were cut from the tubes and prepared for metallographic analyses by standard grinding and polishing and by etching. Quantitative image analysis was performed on optical micrographs taken from the weld bead in order to calculate the ferrite and austenite volume fractions. Determination of the phase volume fractions was done by the manual point count method on micrographs taken at 500x magnifications, in accordance to ASTM E-562 standard. Microhardness measurements were also performed on the prepared samples, both longitudinally and transversally to the weld axis.

A Vickers microhardness tester (HV5) with a load on the indenter of 49 N was used for this purpose.

Table 1. Chemical composition of SAF 2205 steel (%)

C max.	Si max.	Mn max.	P max.	S max.	Cr	Ni	Mo	N
0,030	0,8	1,2	0,035	0,015	25	7	4	0,3

Table 2. Mechanical properties of SAF 2205 steel at 20 °C

Yield point $R_{p0,2}$ (MPa) min.	$R_{p0,1}$ (MPa) min.	Tensile strength R_m (MPa)	Elongation A (%) min.	Hardness max. (HRC)
565	640	772	25	22

Table 3. Laser parameters used at welding

Sample	Laser power [kW]	Welding speed [$mm.s^{-1}$]	Shielding gas surface/root	Gas flow rate [$l.min^{-1}$]	Fokus height [mm]	Heat input [$kJ.cm^{-1}$]
1	4	15	He/He	20	0	2,6
2	4	15	N_2/N_2	20	0	2,6

3. RESULTS

Experiments include evaluation of the formation created welds, further analysis of the macrostructure and microstructure and the determination of the proportion of ferrite in the weld metal.

3.1. Characteristic surface of welds

Assessed for the formation of the weld is not only an aesthetic character, given that the pores, splash as well as other errors, whether on the outside or the inside (the root) of the weld defects are unacceptable and may cause a reduction in the required properties of welded constructions and weldments and thus may lead to degradation and damage. In the Fig.1 can be seen welds created by the same welding parameters, using two types of shielding gas, helium and nitrogen.

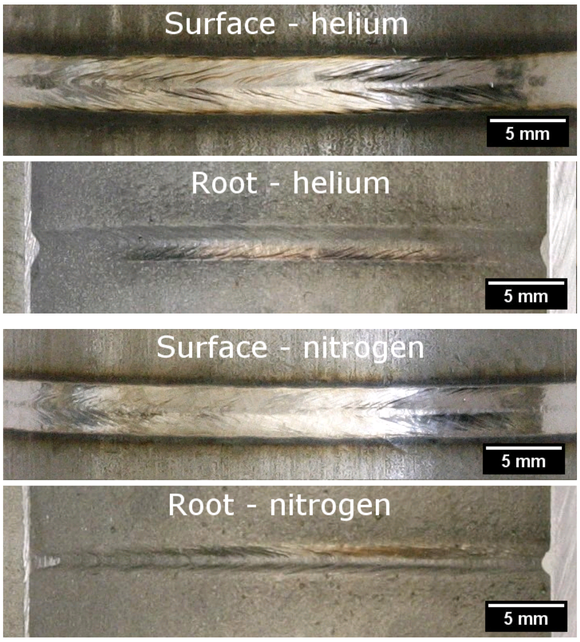
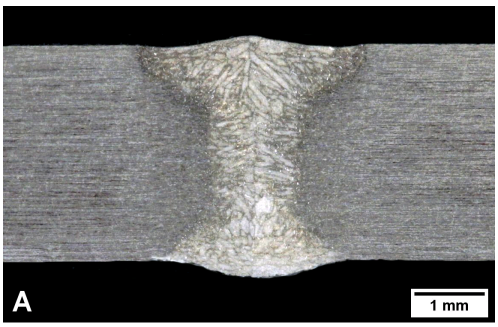


Fig. 1. Characteristic surface and root

3.2. Analysis of macrostructure

In both macrostructure can observe some of the excess weld metal base material, which means that smelting was a slight increase in volume of the weld. Welded surface and the angle of transition from weld to base material were suitable. Welded joints were also evaluated in terms of integrity. There were no technological defects. In neither case were observed in the weld metal, or heat-affected zone cracks, pores or shrinkage. Fig.2a documents macrostructure of the cross section at laser beam welding with helium shielding gas. Fig.2b documents macrostructure of the cross section with nitrogen shielding gas.



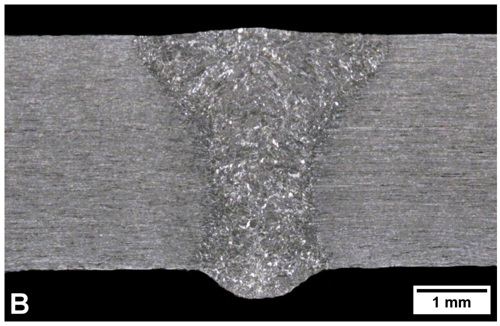


Fig. 2. Macrostructure of welds with shielding gases, a) Helium, b) Nitrogen

3.3. Analysis of microstructure

Microstructural observations of welded joints were performed by use of light microscopy. Microstructure of base metal (BM) is linear, what corresponds to tubular products. Bright particles in the photos represent austenite and the dark ones ferrite. Structural character of individual samples actually does not differ. Fig.3 shows the microstructure of laser weld joints after welding with helium shielding gas.

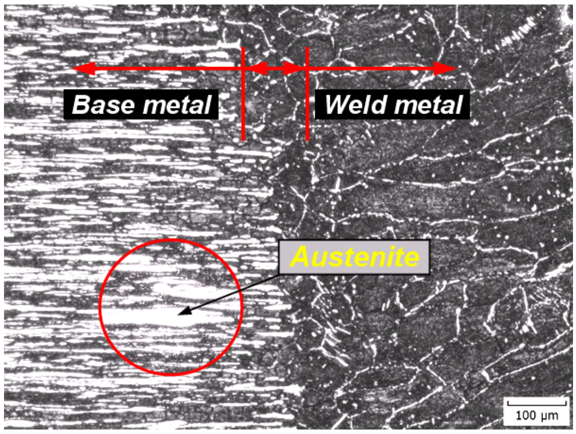


Fig. 3. Microstructure of weld with helium

Microstructure of base metal consists of ferrite with austenite islands. The fusion line is distinct, where the fused zone has polyhedral and acicular structure with finer grain than further in weld metal. Fusion zone between the weld and the base metal is contiguous, relatively plain and without any integrity defects. These facts point to the perfect metallurgic joint of the weld and the basic material. Microstructure of weld metal is composed of ferrite and on frontiers grains is excluded austenite. There are no non-integrity signs like cracks or poruses in the weld that would be visible to the naked eye.

Fig.4 shows the microstructure of laser weld joints after welding with nitrogen shielding gas.

The fusion line is distinct, where the fused zone has polyhedral and acicular structure with finer grain than further in weld metal. Fusion zone between the weld and the base metal is without any integrity defects. These facts point to the good metallurgic joint of the weld and the basic material. The matrix of weld is formed of ferrite and austenite forms a network along the grain boundaries [3].

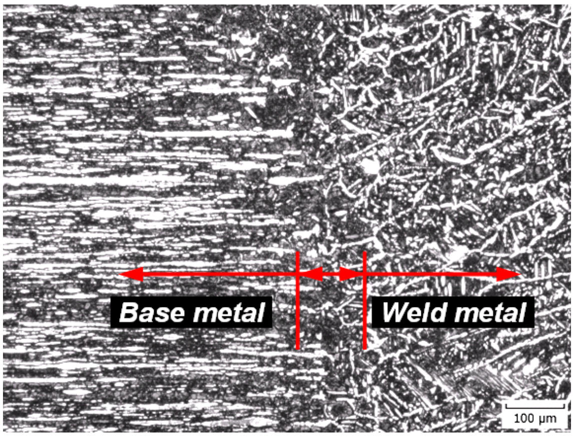


Fig. 4. Microstructure of weld with nitrogen

Austenite is excluded on frontiers grains the ferritic grains in form of massive particles. Structure coarsening was observed in the upper part of weld. Typical columnar ferrite grains can be observed along the boundaries with excluded austenite, which had partially dendritic character and in some zones also acicular morphology was observed [3]. There are no non-integrity signs like cracks or poruses in the weld and his surroundings.

3.4. Ferrite content

Measurement of ferrite proportion was performed by the test according to ASTM E 562 standard, which specifies the ferrite amount in percentual content of ferrite [5]. Ferrite content is shown in Fig 5.

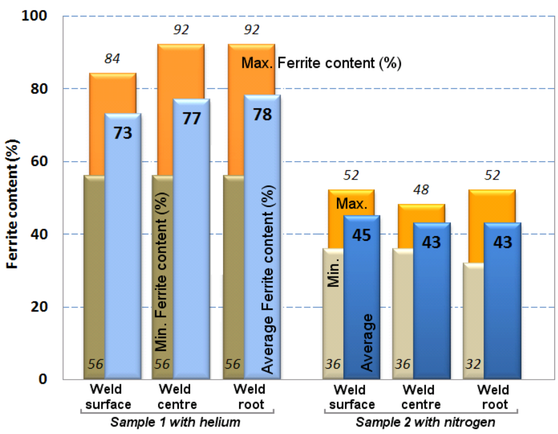


Fig. 5. Ferrite content in welded joints

Ferrite content is high in welded joints with shielding gas as helium. The ferrite % in weld metal was in all cases higher than in the base metal. Generally the content of ferrite > 70% is considered as high. Acceptable phase balance is usually limited in range 35 - 60%.Ferrite content in all weld metals of tested variants is highest in the root zone of penetration runs compared to surface and centre of penetration depth. In welded joints with using nitrogen as shielding gas is total average 44 % what is very favorable and corresponds to requirements for base metal.

4. CONCLUSION

Based on the experiments performed on laser beam welded joints fabricated in duplex stainless steel type SAF 2205, the following can be stated. The structure of reference weld metal consisted of columnar ferrite grains with austenite precipitated on the grain boundaries. In specimens welded with nitrogen as shielding gas, the grain refining and precipitation of austenite also inside ferritic particles occurred. In no case the defects like cracks or pores were observed. Weld root overrunning was not observed. It was proved, that application of nitrogen shielding gas made possible to reduce the ferrite content in weld metal even by 32 %.

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EVALUATION OF RESIDUAL STRESS IN COINAGE TOOLS

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Abstract

The article presents a simulation and experimental study of material stress generated during relief forming. The resulting state of stress on die surface significantly influences die lifetime and thus the importance of proper heat treatment is emphasized.

Keywords: Coinage; Pressing; Material stress; Simulation; Stress measurement; Heat treatment.

1. INTRODUCTION

In the production process of dies, multiple operations are used where changes of shape and dimensions are achieved by different technologies accompanied by effects of various external forces.

Stress in the material causes either elastic or plastic deformation. Stress magnitude depends on elementary operations of manufacturing process. Moreover, a superposition of different types of stress occurs.

Residual stress can be characterized by its magnitude, gradient, and type of stress. Cold forming technology results in pressure stress, on the other hand machining causes tensile stress. Stress parameters depend on other parameters of surface integrity including material properties. Especially in case of forming operations where material is cold plastically deformed, it is necessary to use subsequent proper heat treatment to reduce the internal stress. [1]

2. METHODS OF RESIDUAL STRESS EVALUATION

Verification of the presence of stress in the semi-finished product with and without relief can be carried out by the following methods:

1. Numerical simulation of stress state when relief is pressed,

2. Experimental measurements of sub-surface stress.

2.1. Numerical simulation of stress during forming

Forming processes of the relief was simulated using MSC.SuperForge software package. The software enables to monitor the process of plastic flow of material in a tool and provides coloured map of magnitude and deformation rate of change, stress state, temperature fields, and contact pressures acting on the tool surface during cavity filling. [2]

Numerical simulation of die forging process consists of the following phases:

• Preparation phase of the simulation: creation of geometric models of tools (AutoCAD, Catia), selection of process type, 2D/3D display mode, Hot / Cold, entering input data for formed material and tool material, moulding machine, and temperature.

• Starting and running simulation task of prepared forming process. [3]

Input parameters for the simulation software: force magnitudes, relief depth, procedure scheme, and a way of roller placement in the compartment located in the lower part of the tool. A model of a forming process involving mother die and a semi-finished product in the jig is displayed in Fig.1. Assumed material of the semi-finished product was DB.DIN 1.2550 (tool steel Böhler K 455).

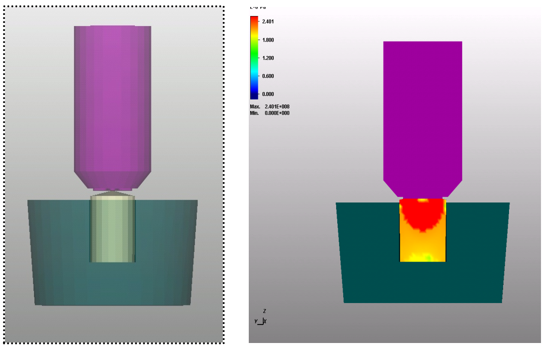

Fig. 1. Illustration of forming process in closed tool

2.2. Experimental measurement of stress

Fig. 2 displays a pair of rollers made from tool steel with and without relief. Tensometric sensors for measurement of residual stress were attached on the contact surface of the rollers as illustrated in Fig. 3.

Fig. 2. Rollers prior to measurement of stress

The measurements were completed at the Department of Technology and Materials Engineering, FVTM - UJEP in Ústí nad Labem using SYNT, RESTAN drilling equipment. Measurement principle is given in Fig. 4. Drilling into the surface of the rollers is made by means of an end-milling tool in 30 steps for each surface.

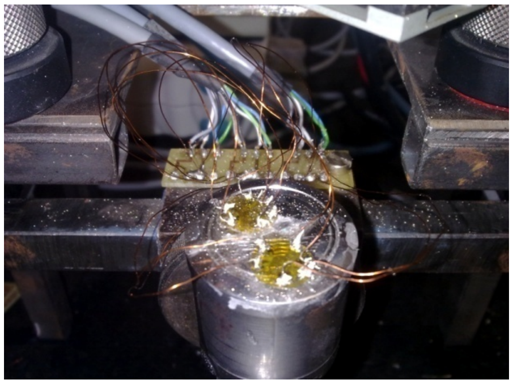

Fig. 3. Detail of roller with tensometers

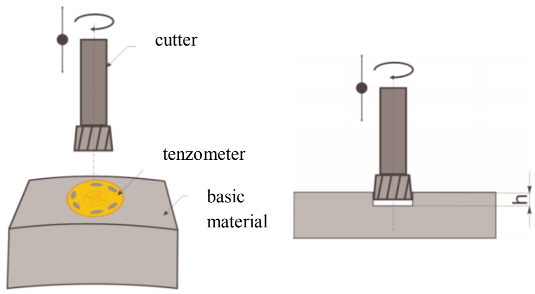

Fig. 4. Measurement of residual stress using end-milling tool

3. RESULTS AND DISCUSION

Simulation results are visualized in Fig. 5 and Fig. 6.

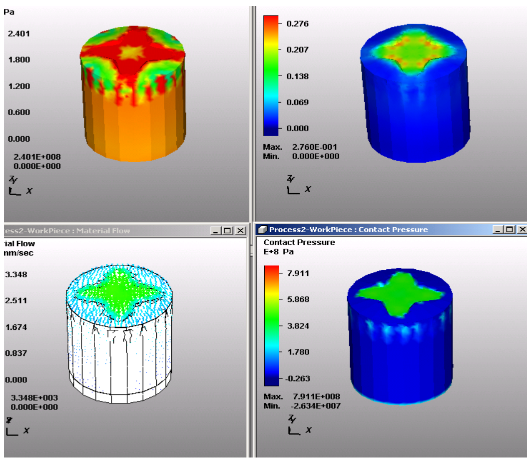

Fig. 5. Immediate results at 50 % of simulation

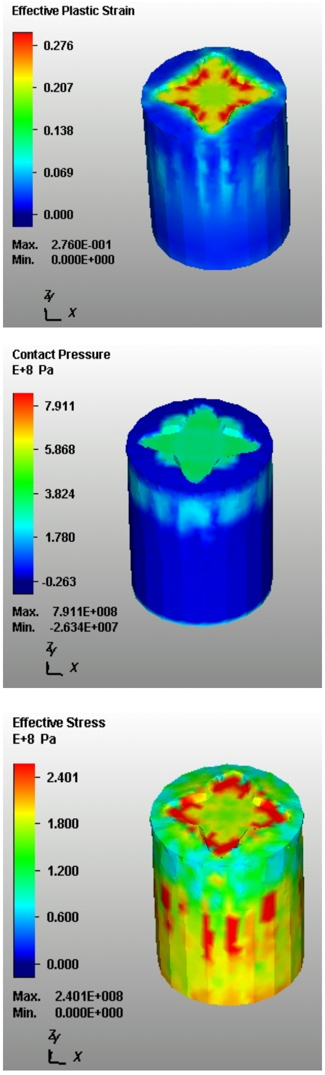

Fig. 6. Map of deformation, effective stress and contact pressure at 100 % of simulation

Fig. 6 schematically illustrates simulation of stress phenomena during forming process.

From the coloured mapping it is evident that stress values range from 100 to 240 MPa. Even at 50 % of simulation process of relief forming, stress magnitude reached values up to 240 MPa. Lower values of stress ranging from 120 to 180 MPa were achieved in the final phase of the simulation process.

Results of experimental measurements: Selected results of measurements performed on the face of the roller with and without relief are summarized in Table 1.

Table 1.Values of residual stresses

Depth [mm]	Compressive stress [MPa]	
	Roller without relief	Roller with relief
0,001	-6,199	-190
0,003	-163,6	-218
0,005	-229,4	-230
0,008	-241,8	-237
0,013	-236,5	-257
0,017	-226,5	-271
0,022	-214,6	-294
0,028	-206,0	-311,6
0,035	-200,5	-364,3
0,043	-200,6	-417,4
0,051	-206,2	-461,1
0,06	-216,9	-498,9
0,07	-232,8	-532,2
0,081	-251,6	-558,4
0,092	-271,4	-578,5
0,104	-290,2	-593,8
0,117	-306,9	-606,1

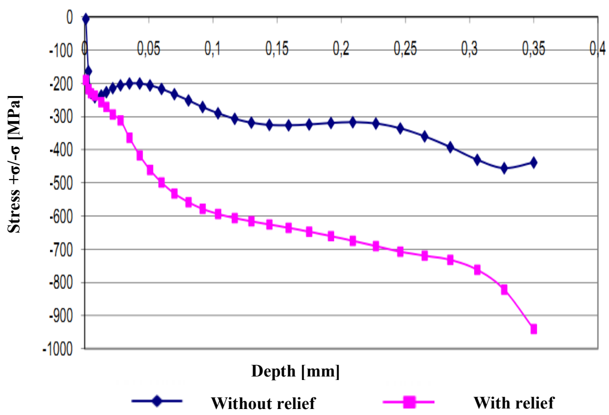

Fig. 7. Graphical record of measured stress versus depth data under surface of measured elements

Measured data are graphically displayed in Fig. 7. The graphical plots display residual pressure stress on the roller front faces with respect to depth. During measurements, maximum depth 0.35 mm was used.

On the front conical area of the roller (blue line) the pressure stress immediately under the roller surface are steeply increased from zero to -250 MPa; in depth 0.05 mm the stress is decreased to -200 MPa. Between 0.15 to 0.25 mm the stress values are almost constant and equal to -300 MPa and then rise again above -400 MPa.

In the case of a roller with relief (pink line), pressure stress immediately under the roller surface, the rate of change of pressure stress is lower. In depth 0.05 mm the stress has a value of -450 MPa. In depth 0.1 mm, the value is equal to -600 MPa and then it is further slightly increased up to depth 0.35 mm up to value -900 MPa.

Presented results indicate that forces generated during machining process (roller without relief) cause significantly lower stress than forces during forming process (roller with relief).

4. CONCLUSIONS

Presented simulation has only an illustrative character. It was found that residual stress has a pressure character, the stress reaches the values up to -240 MPa. Experimental measurements provide information about magnitude and characteristics of residual stresses. Achieved experimental results are in good agreement with simulation results.

Selection of relief production process depends also on die material properties. Forming process for relief production is suitable for tool steel with appropriate plasticity with lower hardness after hardening. A representative material for die production is e.g. tool steel Böhler K455. [4]

If a material with higher content of alloy elements is used such as Böhler S390 Microclean steel produced by powder metallurgy, then relief must be produced by machining on NC milling machines. This method is time consuming, although in terms of residual stress it is more advantageous. Mass production of coins results in increased consumption of tools and so the production of relief using machining technology is less cost effective. Machining is used only for production of dies for smaller volumes, such as medals or commemorative coins.

Residual stress in the material created by relief forming are higher than in case of machining. That means that in die production procedure, annealing should take place after relief forming to prevent premature creation of cracks e.g. due to subsequent hardening.

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The impact analysis of the selected abrasive water nozzle parameters shape in relation to the machined surface geometrical accuracy

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Abstract

Waterjet cutting technology represents a new approach of shape cutting of various materials, under conditions of cold cut without influencing the material on the cutting edge. In the article, the impact analysis of the water jet geometrical accuracy is solved, in relation to the machined surface. The geometrical parameters of the abrasive nozzle outlet are measured in order to perform correction of parameters during the water jet cutting, depending on geometry of the workpiece. In the technology process, the nozzle is to be replaced and measurements carried out by the measurement system, which is not a part of the cutting jet. Therefore, the work is focused on proposal of optimal measurement system, which enables direct measurement in the technological process. In the process of abrasive water jet cutting abrasive wear occurs to the water nozzle action of the abrasive particles. The size of the wear depends on technological parameters of cutting material from a water nozzle, which is produced. Influence blending there is Abrasive removal material that is to say slicing the principle of high-speed grinding. Article contains proposals for measurements and description experiments carried out on specific workplace cutting waterjet. At the same time are the practical conclusions from the measurements.

Keywords: Nozzle; Waterjet; Measurement; Cutting; Parameters.

1. INTRODUCTION

In the process of abrasive water jet cutting abrasive wear occurs on the abrasive nozzle. Wear depends on the size range of settings and technological parameters of the material from which the nozzle is made. It is very important to control the nozzle wear, which affects the quality of cutting surface, its roughness and the overall performance of the cutting device.

2. SIZE OF THE ABRASIVE WATER NOZZLE WEAR

The purpose of the final reduction in cross-section of the nozzle guide or limit the abrasive laden water flow from the upper culmination of the erosion of the base piece. This reduction ensures that the direction of the product were transported all the abrasive particles. The greatest abrasive wear of the nozzle is at the top of the inlet. This fact suggests that the fragmentation of abrasives is happening increasingly in the top and no bottom nozzle.

At the top of the nozzle are a higher number of reflections due to the low velocity particles. At this stage, the particles also have more sharp edges, which increase the possibility of erosion [1].

This was confirmed by the experiment carried out. Abrasive nozzle, made of tungsten carbide, a wire cutting technology, cut along its length into two equal parts. Using the scanner can be optically recorded her inner wear (Fig. 1). From the measurements confirmed that the nozzle is the most wear and tear in its upper part (Fig. 2).

Fig. 1. Cut the nozzle

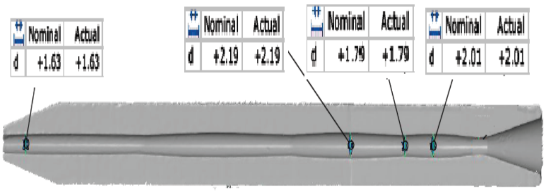
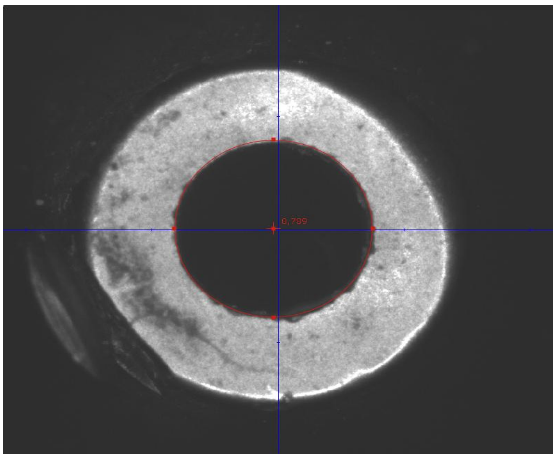


Fig. 2. Measured values of the internal nozzle wear

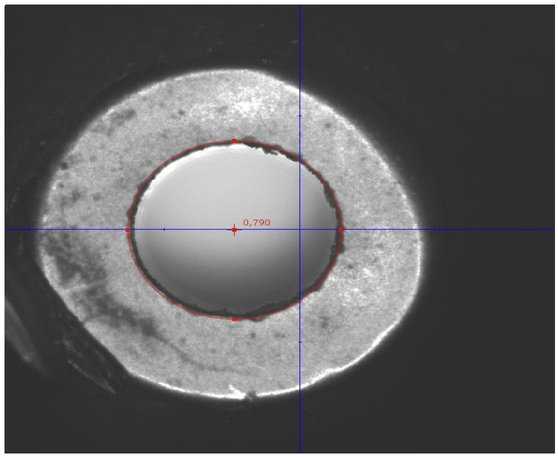
3. MOTION CONTROL NOZZLE WEAR

In engineering practice there is pretty much the nozzle to control only visually. The experiment samples were collected using an abrasive nozzle of the same diameter and measured how they wear in the cutting process. This means that the deformed shape of watching an outlet nozzle. Shapes outlet nozzles were documented using 3D scanner.

Deformed shapes of holes are shown in Fig. 3.



a)



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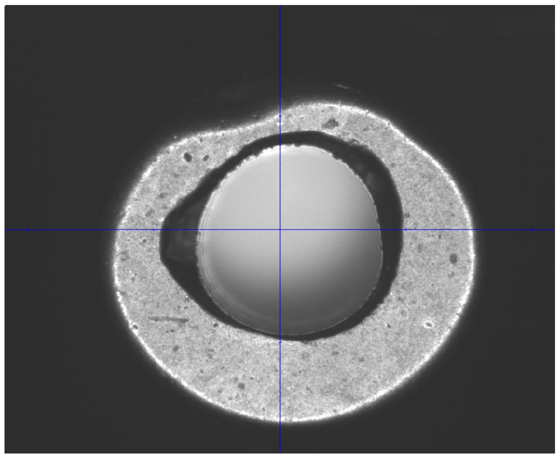

c)

Fig. 3. Deformed shapes outlet abrasive nozzle a) larger circular hole, b) ellipse c) Polygon

Generally, it is possible that the spout can be distorted:
a) to form an enlarged nearly circular hole, the increasing diameter of the original hole
b) the shape of an ellipse
c) to form Polygon

The biggest influence on abrasive wear of the nozzle has abrasives. Abrasive particles are accelerated and pushed out of power, affecting the inner wall of the nozzle, which wears. Given the material from which the abrasive nozzle made, it leads to a faster or slower wear [2].

Purchasing abrasive nozzle is highly expensive. Price nozzle because of its size, material and quality ranges from about 50 to 100 Euro / pc. Therefore, each company is trying to use the abrasive nozzle as long as possible. The aim of the experiment was therefore to propose a measuring device which can keep track of the size of the abrasive wear of the nozzle. Based on the measured results then determine whether it is possible to the nozzle in the cutting process and continue to be used in which the corresponding cutting parameters [3].

Wear of the abrasive nozzle is reflected in the quality of cut and rising production costs. In order to accurately and quickly measure the shape of the watch, deformed outlet nozzle is designed to be simple and inexpensive measuring device.

Given the small diameter outlet nozzles 0.15 ÷ 2 mm in the experiment was designed using control VISION SENSORS inspection camera system. Its advantage is so well take a small hole.

These systems allow you to quickly and accurately assess the quality of the product. Systems are composed as a set of cameras, lenses, lights, processing units. In practice they are used to control the presence of elements in reports, object identification, control and other dimensions [3].

In the case of the proposed report was used black camera Banner, with a resolution of 1280 x 1024 pixels and software equipment. When measuring technique was important shooting settings and light jets. In this case it was used back lighting. A part of the proposed system was computing software that displays the images and allows measurement of the displayed object. Based on the simultaneous assess whether the measured dimensions of the object are in good tolerances (usable), respectively bad (useless) product. Recording and evaluation of measurement is provided communication software that automatically saves the measured values and information.

The measurement system uses the BLOB function. Its task is to detect the presence of an object given the number of measured black or white points [4].

In our case, the Representative BLOB reference circle, representing the ideal outlet opening of the new abrasive jet, with a value of λ = 3.14. Values given in the system "pixels" and represent the values in mm. It can be set directly display values mm.

Measurement procedure: In a reference value stored BLOB. Worn nozzle is inserted into the stand and strengthened between the camera and slide the lower illumination. The nozzle is enlightened. After setting the image quality is an outlet scans the image (anamorphic spout) on PC monitor, in the evaluation software. Then measured the size of wear. This measurement was carried out at a distance from the nozzle opening approximately 45 mm camera. Given the size and shape of the measured values of the deformed hole can be determined whether the nozzle still in use in the production process.

Guiding value is the "eccentricity". The eccentricity of the hole is the reference value 1. If the hole is deformed, the value is higher, lower or the same.

A worker on the basis of the measured value can be determined whether it will be applicable to other jet cutting. Likewise, it may be a guiding value "Perimeter". His ideal reference value is λ = 3.14.

In Fig. 4 is shown a comparison of new and nearly worn-out hole and measured values.

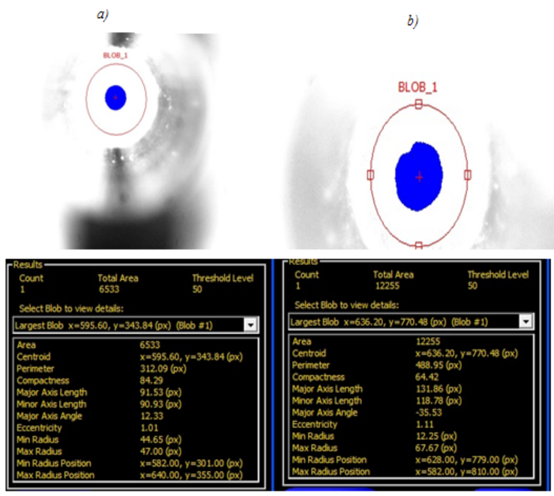

Fig. 4. Comparison of the two sensing nozzle a) hole the new nozzle b) hole the deformed nozzle

4. RESULTS

The experiment samples were collected using an abrasive nozzle diameter and using the same scanner were recorded most distorting forms an outlet nozzle. It was assessed that the opening is deformed into the shape of an ellipse, polygon, or expanding the diameter of the hole almost circular shape. The most ideal for cutting are considered for their use last case - the increasing diameter hole in a circle. This is because the water jet was still the almost circular shape and wears compensating adjustment for cutting larger correction.

It was also addressed issues of control of the size of the abrasive wear of the nozzle. Given the small diameter outlet nozzles (0.15 ÷ 2 mm) was designed using control VISION SENSORS inspection camera system. The proposed measuring system works on a BLOB. Given the size and shape of the measured values of the deformed hole to hole reference is impossible to determine whether the nozzle still in use in the production process. Determination of acceptable values will be subject to the nozzle wear our further investigation. Solve problems, to wear what values can still cut the nozzle, is the subject of our further investigation. Based on measured values of wear will be governed by the amount of abrasive in the abrasive feed nozzle so that the corrected width of the cutting beam to an acceptable value. Assumption is that jets with high wear and tear will not be used for cutting thick materials and for precise cutting. However, they will be used for cutting thin materials, soft materials and a quality not required precision cutting.

5. CONCLUSIONS

This post has been focused on analysis and contribution to the issues of wear and abrasive water jets control. In connection with the Waterjet technology, and high costs for business are constantly buying abrasives and abrasive water jets. It is very important to choose optimal quality and the materials from which they are made. These costs can therefore affect the correct choice and use in the cutting process. Problems of wear, abrasive water jets is still topical area studied. The aim of manufacturing companies is as much to extend the life of nozzles and reducing the costs of their business purchase. Abrasive nozzle wear depends on technological parameters set for cutting a material of which they are made. Adverse nozzle wear is manifested mainly low-quality cut and poor roughness of cut surfaces. Based on these aspects and visual recovery occurs to assess the suitability or unsuitability of its further use when cutting.

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Study on helical drill wear when drilling low carbon stainless steel X02Cr17Ni9TiN and accompanying phenomena in the cutting zone

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Abstract

In The basic hypothesis of this article focuses on the study of cutting tool wear with regard to the elimination of occurrence of poor-quality holes when drilling into new austenitic ELC (Extra Low Carbon) X02Cr17Ni9TiN steel stainless steel. The problem of drilling holes with diameter *D*=5 to 8 mm resides in the fact that 15 to 20% of these holes do not comply with prescribed requested requirements. The cutting tools (helical drills as monoliths) get damaged and wear out. The result of the damage is very often the unforeseen destruction of the cutting tools; therefore their operational tool life is reduced. On the basis of practical experience and experiments carried out in the past 15 years, we have observed that the operational tool life of helical drills is reduced by 10 to 18 %. This article presents the results of experiments focusing on the study of the damage process in helical drills with diameter *d*=7.0 mm when drilling into new austenitic ELC stainless steel. This study also includes an analysis of accompanying phenomena in the cutting zone by measuring some selected parameters. The results of the experiments were compared with Cr18Ni8 steel and then verified when drilling holes into specific products.

Keywords: Product Development; Drilling; Tool Wear; Helical Drill; Cutting Zone; ELC stainless steel.

1. INTRODUCTION

Austenitic stainless steels are produced with graded carbon content. The content of chromium steels in this group of about 18% nickel content is tailored to the requirement that the steel structure was largely austenite. Minor phases present in the structure are made of ferrite and carbides of chromium δ mainly $M_{23}C_6$ type. Austenite is in this group of steels stable even at temperatures well below freezing. Mechanical properties in the solvating annealing, where part of the solution passes into the carbide,depending on the content carbon. Machining austenitic steels is more difficult compared with the low and medium alloy steels [1,3,5]. High strength, low thermal conductivity, high ductility and a tendency to high firming austenitic stainless steels are the main factors that make their machinability difficult. Most difficult place to drill deep holes with small diameter [4,6,11].

2. METHODS AND MATERIALS USED FOR RESEARCH

For the purposes of the experiments, the applied technical system was: machine-tool-fixture-workpiece: Machine-Chiron FZ12, CNC, Fig.1. Tool-helical drill with diameter *d*=7.0 mm, new cutting area structure in sintered carbide with different cutting part. Tool fixture: high-precision hydraulic clamping head. Workpiece fixture- mechanical vice. Workpiece- the following materials were employed for the purposes of experimental measurements: Cr18Ni8 steel, X02Cr17Ni9TiN steel with low carbon content, i.e. ELC (Extra Low Carbon) steel. Samples with the following dimensions were used for the purposes of experimental measurements: bxhxℓ (20x20x100) mm. Work place - Nuremberg Research & Development Centre.

Fig. 1. Machining equipment–Chiron FZ12, CNC

Cutting conditions: cutting speed in interval v_c=30-80 m per min, feed in interval f=0.02-0.08 mm per rev.

Table 1. Chemical composition of stainless steels in % ([wt.%])

Steel	C	Cr	Ni	Mn	Ti	N	P	S
X02Cr17Ni9TiN	0.002	16.8	8.8	1.8	0.003	0.03	0.01	0.015
Cr18Ni8	0.2	17.8	7.65	1.6	0.001	-	0.03	0.035

Machining method-Dry Machining. With regard to cutting tool life, the following criterion was applied: VB_k=0.1 mm. Measurement was carried out by means of an optical microscope without extracting the cutting tool from the clamping fixture. The cutting tools and fragments were analyzed using an electron microscope (SEM).

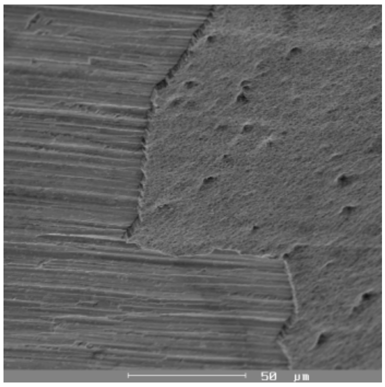
Samples for metallographic analysis were collected spark so that the plane metallographic sections axis hole. Subsequently, the samples were prepared and ready in dentacryle conventional metallographic procedures.

For purposes of analysis has been used light microscopy experimental technique: an inverted metallographic microscope for observation in polarized light and differential interference contrast using (DIC).

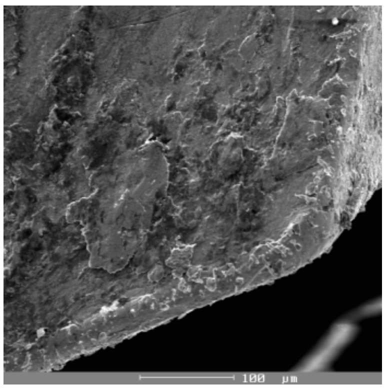
To verify the value of the depth of plastically deformed zones around the drilled holes (determined by light microscopy) technique was used for scanning electron microscopy - with a JEOL JSM 7000F autoemission nozzle. Microhardness plastically deformed zone was set at a distance of 60 μm for austenitic steel X02Cr17Ni9TiN.

3. RESULTS AND ACHIEVEMENTS

Tool wear occurred continuously for Cr18Ni8 steel with the use of a cutting tool in dry machining. In this respect, at increasing cutting speeds tool plastic deformation takes place with gradual laminar flaking of the surface on the cutting tool (Figure 2a) and with destruction of the coat (frittering) over the front area (Figure 2b); tool wear is influenced by the formation of built-up edges and by coat flaking.



a)



b)

Fig. 2. Tool wear
a) Coat damage on dorsal area - gradual coat laminar flaking on cutting tool
b) Coat damage - frittering on front area

Stainless steels are influenced by charging due to intensive mechanical reinforcement during machining, [9,11]. . The examination of reinforced surfaces can be carried out by measuring the micro-hardness of the bottom part of the fragment; indeed, the bottom part of the fragment can be considered as the most deformed fragment zone [2,7,8].

Methods of light and scanning electron microscopy was specified range plastically deformed zones in drill holes under the surface of the material X02Cr17Ni9TiN, Figure 3. Information about the strength of hardening in plastically deformed dimensionally small scopes can get a simple-cycle loading-lightening and cyclic (sinusoidal) mode when loading nanoindentation hardness measurements.

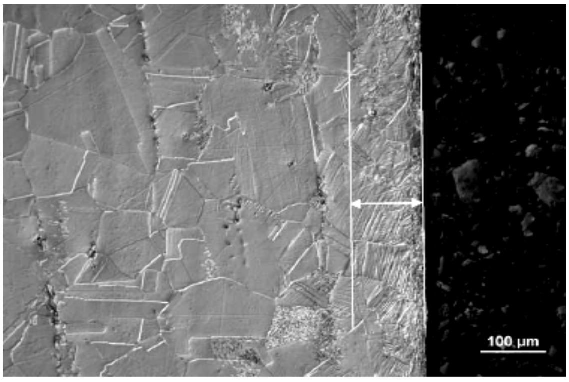


Fig. 3. Hardening under the machined surface - interval 40 - 400 µm, 1.4301 vz. 19CN. D.I.C.

Scattering measurements may be confined to appropriate training part, a good place for measuring and statistically large enough set of measurements. Sinusoidal mode is more advantageous than simple or cyclic loading-lightening.

4. CONCLUSIONS

Cutting tool damage follows a chain of events. After drilling holes the cutting edge was influenced by the formation of Built Up Edge-BUE, as shown in Figure 4. The built-up edge in the face and major flank area might be the result of adhesive wear close to the cutting edge. Holes were made in dry conditions in order to avoid any influence on experiment results with process media. Oxidation and diffusion (as wear mechanisms) were observed in deeper holes (3 to 5xD). One of the basic causes of such mechanisms is the quantity of heat generated in the cutting area when holes are made (here one of the main causes is represented by the low heat conductivity of steel). If we apply a process medium, the above mentioned mechanisms would be substantially influenced–and in some cutting conditions they would be almost non-existent.

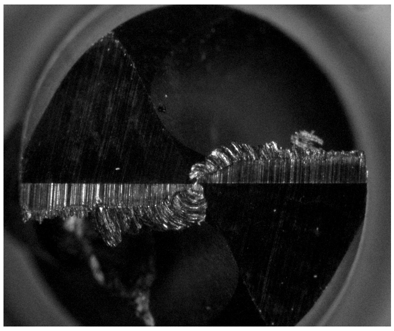


Fig. 4. Formation of built-up edges when drilling X02Cr17Ni9TiN steel

The results of micro-hardness examination these results are as follows:

- Cr18Ni8 steel: fragments are strongly deformed compared to X02Cr17Ni9TiN steel. Austenite fragment, bottom part, v_C=40 m per min, 310 HV (20 g) – if the bottom part of the fragment is measured: austenite 238 HV (20 g)
- X02Cr17Ni9TiN steel: v_C=40 m per min, austenite micro-hardness 224 HV (20 g) – if the bottom part of the fragment is measured: austenite 232 HV (20 g)

The results presented in this article can be summarized as stated in the following main conclusions for the sake of comparison:

1. Machinability of Cr18Ni8 and X02Cr17Ni9TiN steel is influenced by the formation of BUE. Cr18Ni8 steel tends to form more BUE than X02Cr17Ni9TiN.
2. Tool life (for the applied cutting tool) is between 5 min. and 15 min. – when drilling X02Cr17Ni9TiN steel.
3. BUE formation is caused by adhesive wear; in terms of cohesion, this fact indicates that the above mentioned mechanism is likely to be the predominant mechanism in the damaging process of sintered carbide tools when drilling into X02Cr17Ni9TiN steel.

5. ACKNOWLEDGEMENTS

The authors would like to thank ELBA a.s. Kremnica for the test materials its provided. The authors express their thanks to the VEGA and KEGA grant agencies for supporting the research work and co-financing the projects: VEGA Project n.01/3173/06; VEGA Project 1/0048/10; KEGA Project 3/7166/09; the authors express their thanks to the Research and Development Centre for cutting tools of KENNAMETAL in Nuremberg.

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Research of segment blank holding influence force on complex part drawing

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Abstract

The article deals with the variable blank holder force influence in deep-drawing process on parts quality. In the beginning, there have been realized analyze of the experimental material. Based on achieved results, there have been realized numerical simulations and real stamping of variable blank holder force influence on the complex part drawing. Based on performed experiments and numerical simulations can be stated, that using of variable blank holder force during the drawing process compared with constant blank holder force can markedly improve the process and in terms of parts quality achieve optimal blank holder force and even uniform deformation, respectively thickness reduction.

Keywords: Variable blank holder force; Deep-drawing; Numerical simulation.

1. INTRODUCTION

Production of sheet metal products is one of the basic flat forming production processes mainly because of high productivity, low price and minimal scrap. The drawing process is influenced by many factors (technological, material, design) which cause product defects. Material wrinkle and fracture are two most common and serious defects in drawing process and it define drawing limits. Wrinkle ussually occurs in flange of drawn part by compression stresses and fracture occurs because of tension stresses. To prevent that, blank holder force (BHF) is ussually used. In the case of low blank holder force wrinkle ussually occurs. When increasing the blank holder force, wrinkle is reducing. However, the large value of the blank holder force will cause fracture. Sometimes, we can use constant blank holder force, but in most cases is neccesary to use variable blank holder force and sometimes it is not possible to achieve required quality by using any blank holding force. Therefore, the blank holder force should be modified during process as well as in different places. The article deals with the influence of variable blank holder force on part quality modified during drawing process [1, 2].

2. METHODS AND MATERIALS USED FOR RESEARCH

In the beginning, there was analysed experimental material, then realized numerical simulation and in the end real stamping.

2.1. Experimental material

There was used an experimental material for that work sheet steel of thickness s = 0.69 mm, cold rolled from low-carbon plain steel of ductile quality. Specifications of material chemistry and mechanical properties are shown on Tab. 1 and Tab. 2. Material properties were determined by static tensile test on INSTROM 5569 machine according to STN EN 10002-1 for flat specimens.

2.2. Numerical simulation

There have been used CAE software ETA/Dynaform for simulation based on LS-Dyna. Preparing models (fender) contains from 3D scan of real finished part by 3D scanner ATOS II, then in GOM Inspect software have

Table 1. Chemical properties.

Steel	C [max wt.%]	Mn [max wt. %]	P [max wt. %]	S [max wt. %]	Si [max wt. %]	Al [max wt. %]
DC 01	0.10	0.50	0.030	0.030	0.10	0.020

Table 2. Mechanical properties.

Steel	S_y[MPa]	S_u[MPa]	A_{80}[min%]	r	n	HRB
DC 01	220 ÷ 270	340 ÷ 400	32	> 1.70	> 0.17	> 57

been filled, repaired, reduced and optimized the mesh, cut useless elements, created the binder surface. Subsequently, there were created blank, offset tools (die, punch), draw-beads and defined material (based on static tensile test) and technological parameters corresponding to real conditions in ETA/Dynaform software. The model is shown on Fig. 1 [3].

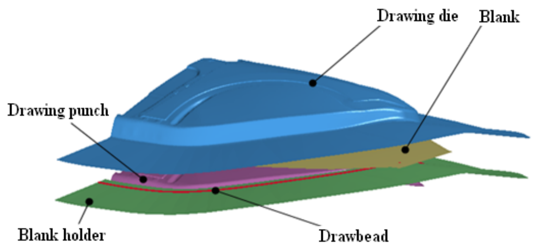

Fig. 1. Simulation model

At the first of all, the constant blank holder force was monitored and based on the results, the safe range was determined. After that, the blank holder force was modified during drawing process and on different places. However, by using BHF on different places, there were no positive effects on this part, thus just modified of BHF during process was realized in this article. There are several ways of evaluation, in that case the thin thinning ratio (25 % of blank thickness) and thick increasing ratio (10 % of blank thickness) was used. The critical areas which were monitored are shown on Fig. 2.

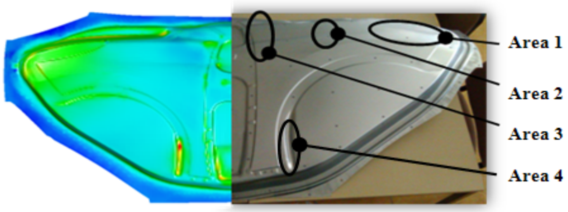

Fig. 2. Critical areas

2.3. Experiment

The mechanical press SML 2000 with hydraulic blank holder was used as an experimental tool.

Before stamping, the grid of 1 mm diameter was printed on the blank. After stamping it has been evaluated by USB microscope DINO Lite Pro shown on Fig. 3 and by micrometer. The safe range of constant blank holder force was set based on numerical simulation.

Fig. 3. Measurement of grid

3. RESULTS AND ACHIEVEMENTS

Based on the realized experiments the following results were achieved.

3.1. Experimental material

Results of static tensile contain values from all directions including normal anisotropy “r” and the strain hardening exponent “n”. Ducility (35.15 %) as well as ratio S_y/S_u (0.694) has appropriate values for deep-drawing. Hardening exponent obtain about equaly values in all directions, which means appropriate uniform deformation.

Normal anisotropy obtains values higher then 1 in all directions, which means that the elongation is generated by width change [4].

3.2. Numerical simulation

As mentioned in chapter 2.2, at first the constant blank holder force was monitored and was determined to range of 400 kN to 500 kN what corresponding to real stamping process. As can be seen from Fig. 4, if force of 400 kN is used, the maximum thinning is 27.36 % in area 4, in area 1 the thinning is 18.99 %, however by increasing the blank holder force the fracture occurs in the area 1 (Fig. 4c). There are shown shear stresses on Fig. 4b. Thick increase ratio is 4.14 %.

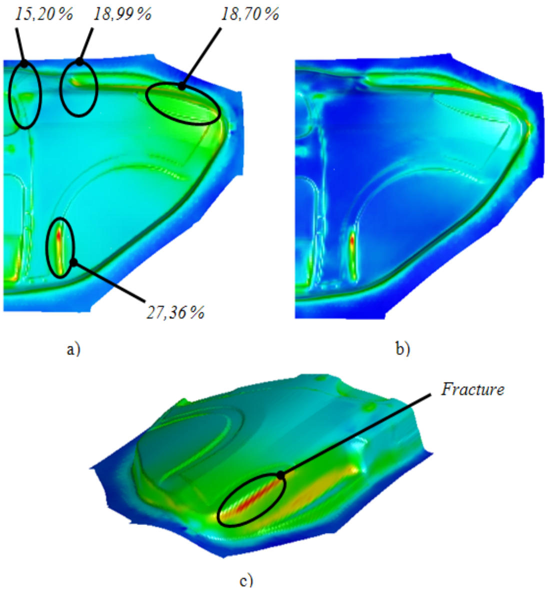

Fig. 4. Simulation results with BHF 400 kN
a) thinning; b) shear stress; c) fracture

If the maximal blank holder force is used (500 kN), maximum thinning is 29.16 %, in the area 1 the thinning is 22.95 %, thick increase ratio is 3.78 % (Fig. 5). The forming limit diagram (FLD) is shown on Fig. 5c and shear stresses on Fig. 5b. As can be seen from Fig. 5c, there is a problem in area marked by red color, but it is just problem of numerical simulation and does not affect to whole simulation.

Based on literature [5], the optimal curve was determined as linear increasing, but for that article, the curve was optimized by every time-step and the resulting curve is shown on Fig. 6c. As can be seen form Fig. 6a, the maximum thinning is 25.43 % in area 4 and 16.83 % in area 1 and in compare with constant blank holder force, the results are much better. Based on the numerical simulations can be stated, that using of variable blank holder force during the drawing process can markedly improve the process

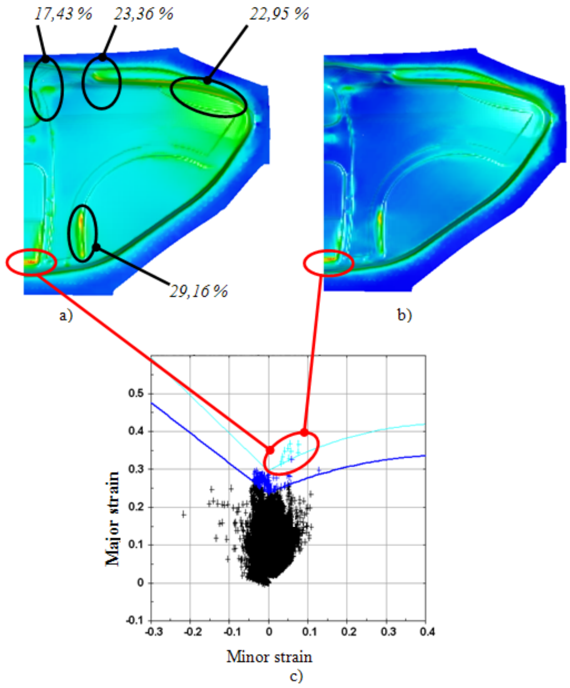

Fig. 5. Simulation results with BHF 500 kN
a) thinning; b) shear stress; c) FLD

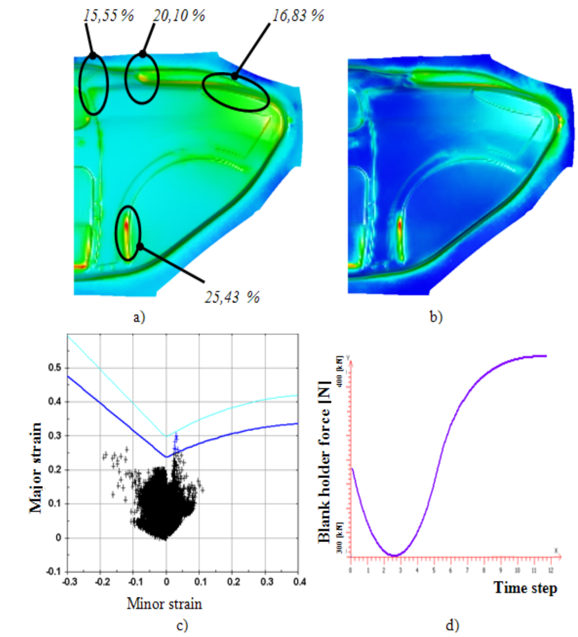

Fig. 6. Simulation results with optimal BHF
a) thinning; b) shear stress; c) FLD; d) optimal curve

3.3. Real stamping

In real stamping process, there was monitored just influence of constant blank holding force (400 kN and 500 kN) and compared with the results of numerical simulation. There were 3 sections according to Fig. 7 and in that sections thickness was measured by using USB microscope Dino Lite Pro (thickness was calculated from deformation grid) and by digital micrometer. There are shown compared results from FEM and experiments for BHF = 500 kN on Fig. 8 and as can be seen results were consistent with numerical simulation. Based on that can be stated, that numerical simulation corresponded well with real stamping process and variable blank holding force can markedly improve the deep-drawing process.

Fig. 7. Sections through the part

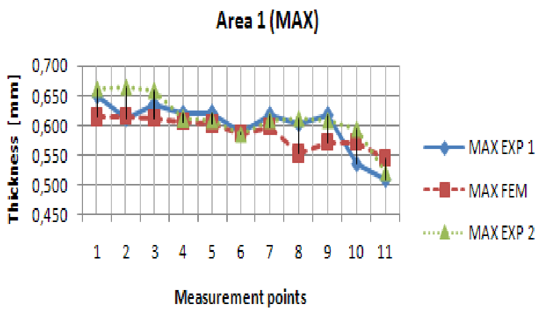

Fig. 8. Compared FEM and experiments

4. CONCLUSIONS

The article deals with the variable blank holder force influence in deep-drawing process on complex part quality. In the beginning, there have been realized analyze of the experimental material. Based on achieved results, there have been realized numerical simulations of variable blank holder force on the complex part. In the end, the complex part stamping was realized. Based on performed experiments and numerical simulations can be stated, that using of variable blank holder force during the drawing process compared with constant blank holder force can markedly improve the process and in terms of parts quality achieve optimal blank holder force and even uniform deformation, respectively thickness reduction. However, in that case by using segment BHF there were no positive effects (it mainly depends on part design), but when modified the BHF during process as has been realized in this article, the process can markedly improve.

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Analysis of weld defect in butt weld according to EN ISO 6520-1, Series 400

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Abstract

Based on the technical documentation received from client, weld defect in butt weld of superheater according to the EN ISO 6520-1, Series 400, is considered. It is found that there are several joints with the same weld defect, but only the most critical is analysed. Model is analysed for calculating and testing conditions, whereas for testing conditions two cases are analysed: testing conditions according to the EN and testing conditions with maximal allowable pressure. Mentioned weld defect is considered as non-standard crack (failure), so the crack tip is defined as stress concentration. Furthermore, creep diagram is constructed according to the values of creep rupture strength for 200 000 hours from EN 10216-2:2002+A2:2007 (E). Based on that norm, for material used in construction and for temperature conditions, it is found that creep does not occur, but anyway, trend line is constructed in order to find the value of creep rupture for considered conditions.

Keywords: 401 – lack of fusion; 402 – lack of penetration; Butt weld; Creep rupture.

1. INTRODUCTION

According to the technical documentation, weld defects 401 – lack of fusion and 402 – lack of penetration (EN ISO 6520-1, Series 400) are considered in butt weld of pipe and elbow. It is observed that one side of root weld is not melted / welded through full thickness.

Although there are several welds with the same defects (pipe - elbow joint and pipe - nozzle joint) only the most critical is analysed and that is butt weld between pipe and elbow. This joint is considered as critical, because the wall thickness of elbow is less than wall thickness of nozzle.

2. GEOMETRY OF WELD GROOVE AND WELD DEFECT

Figure 1 shows geometry of weld groove for pipe - elbow joint and Figure 2 shows geometry of weld defect.

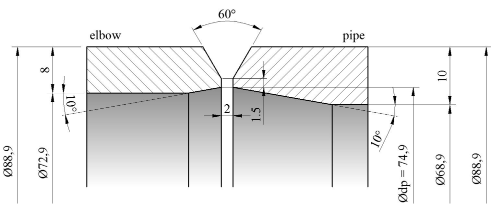

Fig. 1. Geometry and dimensions of weld groove

As mentioned earlier, defect is caused by 401 and 402 type of imperfection, Figure 2. This model is used for FEM analysis.

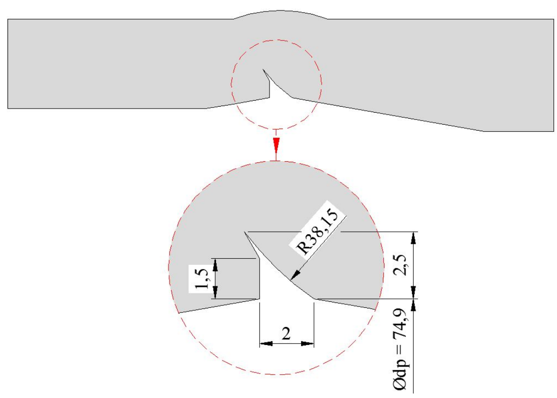

Fig. 2. Geometry and dimensions of weld defect

3. STRESS ANALYSIS OF WELD DEFECT

Stress analysis of weld defect is done by using commercial code for finite element analysis - Ansys.

Model is analysed for calculating and testing conditions, whereas for testing conditions two cases are analysed: testing conditions according to the EN and testing conditions with maximal allowable pressure. Weld defect is considered as a crack, so the crack tip is defined as stress concentration with singular elements around it. Problem is defined as 2D axisymmetrical, because the weld defect is on entire butt weld.

3.1. Pressure/temperature loadings

For calculating conditions internal pressure is p_c = 3,8 MPa and temperature t_c = 405°C.

For testing conditions (at the room temperature t_t = 23°C) according to EN, internal pressure is p_{EN} = 7,94 MPa. And finally for testing conditions with maximal allowable pressure, p_{max} = 11,91 MPa.

3.2. Material model

Material of pipe and elbow is 10 CrMo 9-10. Because assumption of failure by plastic collapse, material is set as linear elastic - ideal plastic with Young's modulus of elasticity E = 185000 MPa and Poisson's ratio ν = 0,3.

According to the EN 10216-2:2002+A2:2007 (E), in case of calculating conditions, for mentioned material and temperature and for wall thickness $T \leq$ 60 mm, proof strength is $R_{p0,2}$ = 205,6 MPa [1], Figure 3.

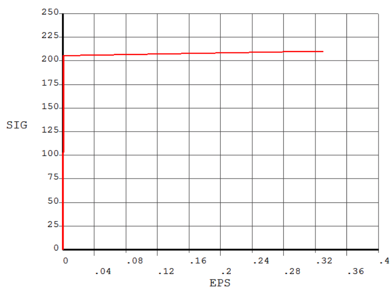

Fig. 3. Material model for calculating conditions

For both cases of testing conditions, for same material at the room temperature and for wall thickness $T \leq$ 16 mm proof strength is $R_{p0,2}$ = 280 MPa [1]. Figure 4 shows material model for both cases of testing conditions.

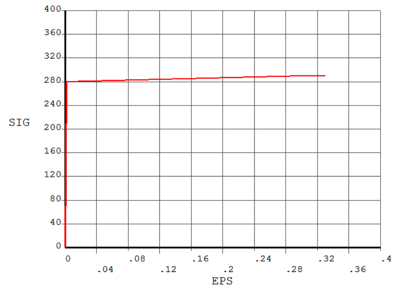

Fig. 4. Material model for both cases of testing conditions

3.3. FEM model

As mentioned earlier, problem is defined as 2D axisymmetrical. Characteristic butt weld plane of axisymmetry is discretized by axisymmetric element PLANE82 from Ansys library of elements, Figure 5. This element provides more accurate results for mixed (quadrilateral - triangular) automatic meshes and can tolerate irregular shapes without as much loss of accuracy. This 8 - node element has compatible displacement shape and it is well suited to model curved boundaries. It has two degrees of freedom at each node: translations in the nodal x and y directions [2].

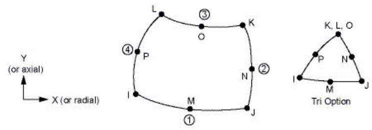

Fig. 5. PLANE82 element geometry [2]

Figure 6 shows finite element mesh with details of mesh around the weld defect. Mesh consists from around 6200 elements and 18800 nodes.

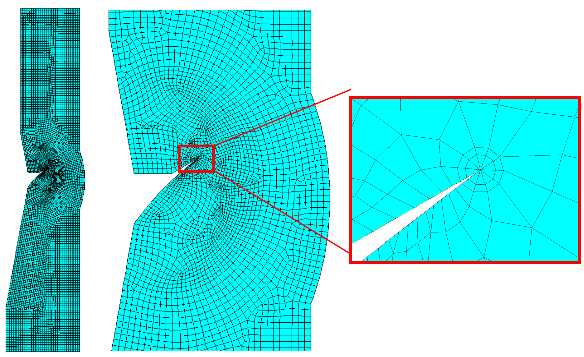

Fig. 6. Details of FEM mesh

3.4. Boundary conditions

Besides load of internal pressure (section 3.1), longitudinal loading is also taken into consideration. Longitudinal loading on the section of the pipe wall is calculated from the longitudinal forces caused by internal pressure, and from total weight of harps (taken from documentation) which is distributed to the one pipe. Furthermore, these two forces are added together and reduced to the 2D cross section of pipe wall. On that way, longitudinal loading is calculated for each case separately, Figure 7.

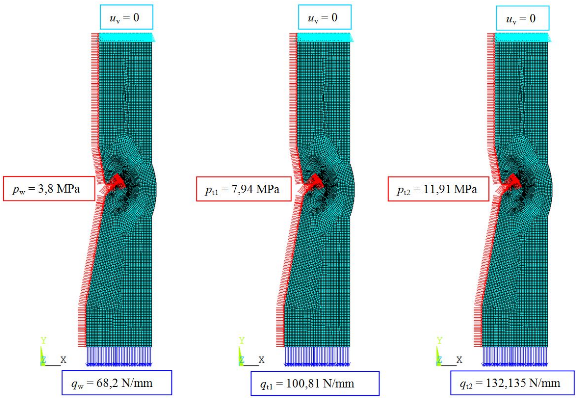

Fig. 7. Boundary conditions for all three cases

3.5. Results

It is obvious that for calculating conditions there is no material yielding at all (Figure 8), so the assumption is that failure by plastic collapse should not occur. Furthermore, there is just a small scale material yielding for case of testing conditions according to the EN (Figure 9). So it can be concluded that even for this case, failure by plastic collapse should not occur.

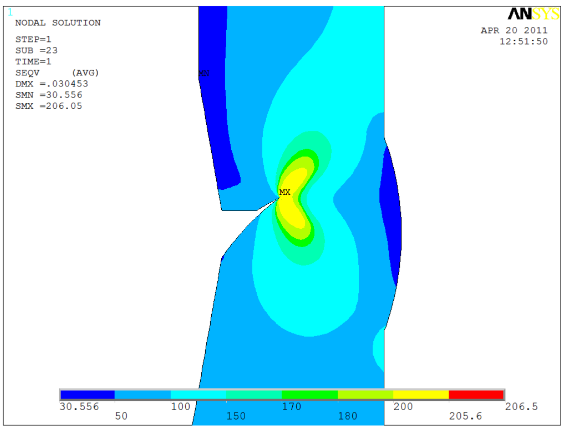

Fig. 8. No material yielding for calculating conditions; σ_{eq}, MPa

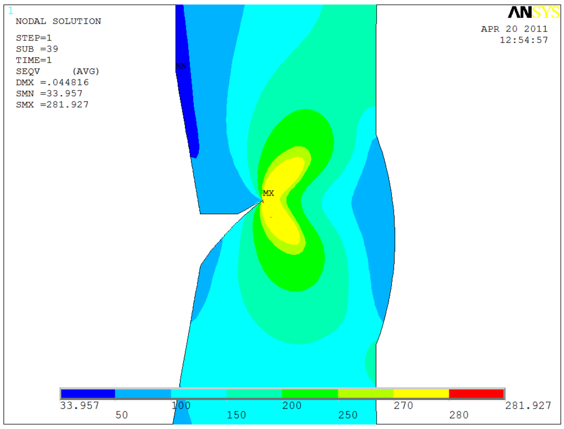

Fig. 9. Small scale material yielding (negligible) for testing conditions (according to the EN); σ_{eq}, MPa

Figure 10 shows that there is large region of material yielding for case of testing conditions, for maximal allowable pressure. Risk of failure by plastic collapse in this case is very large! Therefore, system testing under these conditions will lead to the system fault. So, it is strongly recommended not to test system under these conditions.

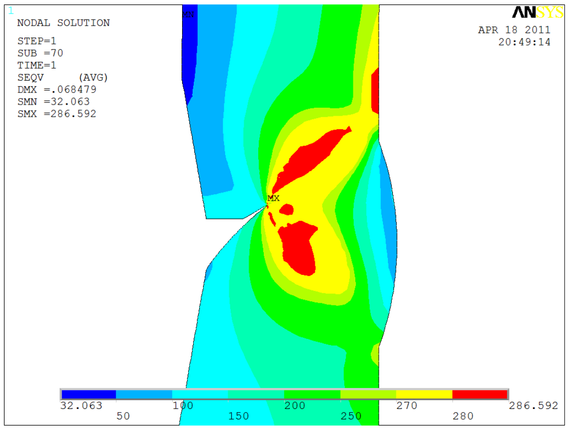

Fig. 10. Material yielding almost through whole pipe wall for testing conditions (max allowable); σ_{eq}, MPa

It is also obvious from Figure 11 that if yield strength is set only for 1 MPa lower ($R_{p0,2}$ = 279 MPa), material yielding is through whole pipe wall, so that is another reason to not test the system under testing conditions with maximal allowable pressure.

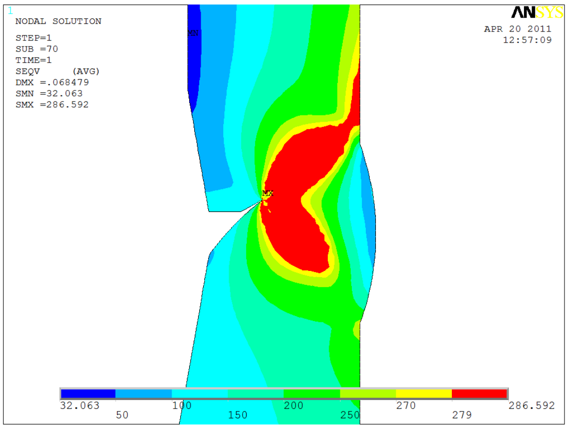

Fig. 11. Material yielding (for $R_{p0,2}$ = 279 MPa) almost through whole pipe wall for testing conditions (max allowable); σ_{eq}, MPa

4. CREEP ANALYSIS OF PROBLEM

According to the values of creep rupture strength for material 10 CrMo 9-10 and for 200 000 h from EN 10216-2:2002+A2:2007 (E) creep diagram is constructed, Figure 12. Mentioned norm contains only values for temperature 450 ÷ 600°C (blue line), what means that for this material creep does not occur until the tepmerature 450°C. Anyway, trend line is found (red line) in order to find value of creep rupture for t_c = 405°C (red dotted line). It is found that creep rupture value for temperature t_c = 405°C is 240 MPa (black dotted line). Because creep rupture value for working temperature is larger than the yield strength (for almost 35 MPa), it is concluded that creep should not occur.

5. CONCLUSIONS

In first two cases (calculating conditions and testing conditions according to the EN) there is no material yielding around the tip of "crack" (defect). In these cases, it is necessary to apply additional load to force failure by plastic collapse. So it can be concluded that in first two cases, failure by plastic collapse should not occur.

In the third case (testing conditions with maximal allowable pressure: p_{max} = 11,91 MPa) material yielding is through whole pipe wall. Therefore, system testing under these conditions will lead to the system fault. So, it is strongly recommended not to test the system under these conditions. During the pressure test, superheater should not be loaded over a test pressure defined by EN: p_{EN} = 7,94 MPa.

Although for material 10 CrMo 9-10 norm EN 10216-2:2002+A2:2007 (E) does not contain value of creep rupture for temperature t_c = 405 °C and 200 000 h, that value is found with trend line and it is around 240 MPa. Because creep rupture value for working temperature is larger than the yield strength at that temperature ($R_{p0,2}$ = 205,6 MPa) for almost 35 MPa, it is concluded that creep should not occour.

6. REFERENCES

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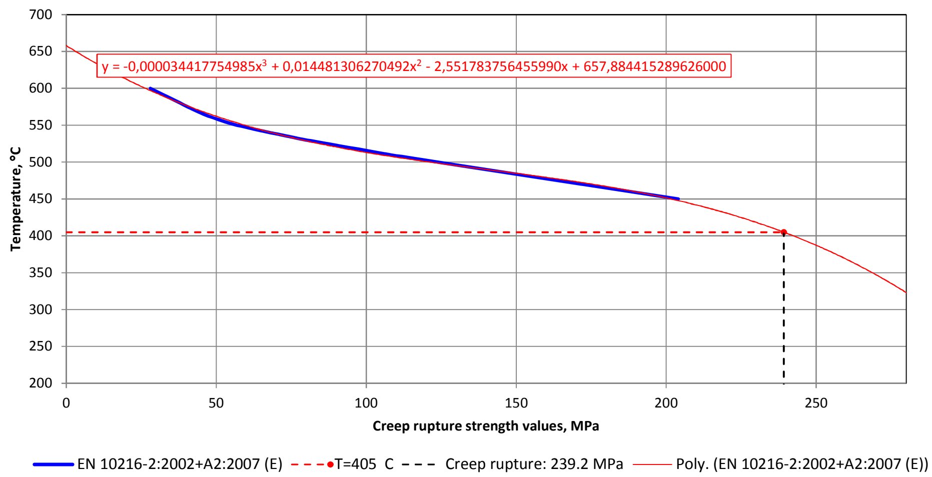

Fig. 12. Creep rupture diagram for material 10CrMo9-10 and for 200 000 h

Review of mobile walker platforms. Concept development.

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Abstract

In this review authors talk about industrial interest towards walker chassis caused by its advantages. The review contains information on existing walker platforms of different types, and about their own project.
Review of existing platforms contains such machines as VolgSTU walker, MPS mecha, Boston Dynamics bots, MIT Wormbot, and 'John Deere' production. Authors' concept also belongs to walker robot's class, and is designed as a quadruped walker robot with individually controlled legs, balance keeping and motion correction system. The robot construction is based on mechatronics approach, and it guarantees that production will be technologically convenient, the robot will be easily modifiable, and chassis will give it advantage on rough terrain.

Keywords: Product Design; Product Development; Mechatronics, Review; Walker Robots.

1. INTRODUCTION

The concept of walker chassis is supposed to provide relative freedom from limits of rugged terrain, where wheels need roads, and caterpillars need rather plain surface without rough ledges or pits, while the walker platform needs only support points.

2. GEARED WALKER TRANSPORT PLATFORMS

The first samples of walker chassis were constructed with mechanical gear with transmission to walker legs. Mathematical model of such system had been created as early as XIX century by P. L. Chebyshev – that model is called 'Lambda-mechanism' [[10]].

It is worth observing a number of modern designs which present certain interest to the subject:

- VolgSTU walker machine [[11]] — this device was built inVolgograd in 1997, designed to work on adverse terrain or swamps. Structurally, it consists of two walker supports attached to central carriage. The vehicle has autonomous power generating system — a diesel generator. There can be placed a cargo or technological devices on the carriage. Vehicle weights 1.6 t, cargo weights 3.5 t.
- Mark Series Bipedal Machines [[6]] — young engineers from Mechanized Propulsion Systems Inc. have built walker mecha[1] of 3 m height with mechanical walk gear, and are intending to show industrial designs, which are aimed e.g. for building operations.

But all these designs are too large and do not allow to control cross-country ability.

[1] Walker, often biped bots.

3. MOBILE ADAPTABLE PLATFORMS OF RESEARCH/ENTERTAINMEN T CLASS

This part of review includes robots with walker chassis, self-orientation and balance system, due to which they are able to keep the state of balance. There're plenty of such systems — the points are attractiveness and futuristic look of chassis, many control ways and difficulty of resolving tasks. The maker range of those systems lies from amateurs to professional companies.

- Honda Asimo and similar — These research androids are involved in a large sphere (of action). E. g., Asimo serves for bot-human interaction research purposes.
- Boston Dynamics LittleDog [[4]] — ultimate version of research quadruped bot, which precede BigDog (see next section).
- MIT WormBot — this bot, built at MIT [[9]] uses inverse kinematics to capture moving path. It uses RC Servo for motion.
- TOPIO [[8]] — Vietnamese company TOSY presented walker android, which is capable to become human's ping-pong partner. According to company's data, the bot is 1.88 m high and weighs 120 kg. It has 38 manipulator's degrees of freedom, advanced Artificial Intelligence and high-precision mechanics built with DC servo. It is also capable of recognizing fast moving objects.

Walker platforms of this type are using direct and separate control for each joint instead of central engine and mechanical gears. It allows to convert its legs/limbs into specifically controlled manipulators, what makes possible to use all degrees of freedom of each leg, for example, for saving platform's balance. (This is especially noticeable in BigDog clip)[[2]].

4. MOBILE ADAPTABLE WALKER PLATFORMS FOR COMMERCIAL USE.

Due to perspectives of use there can be singled out a number of commercial walker platforms which are capable of adapting to terrain. For example:

- BD BigDog [[1]] — quadruped bot, which can move on the rough terrain at a speed of 6,4 kph, carry 154 kg of cargo and climb sloping surface at an angle of 35 degrees. This robot can carry ammunition on a territory unavailable for ordinary surface transport because of walker-type way of moving.
- Timberjack Walking Machine [[6]] — walker combines made by John Deere Finland [[3]] and Plustech [[7]]. This walker represents six-legged vehicle with internal-combustion engine compartment, with hydraulic and electrical drive on legs, and large manipulator, designed for woodcutting and slash removal.

Examples of such platform show definite interest and recognition of development of new walker platforms. Therefore authors are searching for design with controlled cross-country motion. Due to number of reasons, optimal way to search is supposed to be in the area of quadruped bots.

5. THE CONCEPT OF WALKER CHASSIS WITH ADAPTIVE CONTROL

The walker chassis has undoubtful advantages on the certain terrain. This feature has been noticed by many of the listed companies, and is actively used for design. Walker machines with adaptive control keep this advantage in full.

It's supposed to develop walker chassis on basis of mechatronic approach. This platform should have four legs with individual control. Therefore only support points for legs are needed to move on rough terrain.

Balance keeping system is placed in separate block, which is independent from low-level motion-control blocks. Number of joints shouldn't be less than three – this should provide ability to maneuver between and get on the obstacles. Legs should rotate more than 90 degrees in relation to carcass. Rotation angle of every joint should be more than 180 degrees. Adaptation to surface consists of bending groups of joints of every leg to align platform to horizontal state. Degree of aligning depends on data of special three-axis accelerometer block.

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Approaches to creating control strategies for mobile walker robot

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Abstract

The strategies of controlling mobile robots' drives aren't always perfect in their tasks. At the same time efficiency and manufacturability of those strategies could be improved by dividing the system into control levels.
Traditional control scheme could be improved relatively by using multilevel control system. This should allow to reduce required processing power for whole system and certain points, listed in article.
Traditional terminology of control theory describes technological, MIS and executive control levels. Technological level, as lowest control level deals with process data collection and processing, produces the control response and sends the data to higher level. But in suggested scheme it could be called 'operative' due to availability of independent periphery control functions.
MIS as middle-level of the system takes tasks of supporting the manipulators interaction, feedback interaction, building motion schemes and so on. As a subsequent development of central control device of traditional scheme, MIS is also performing higher and lower levels data processing.
Executive control level should use the exceeding powers of PC for decision next tasks: cartography and navigation, visual recognition, device diagnostic, changing control schemes 'on the fly' etc.
Therefore, device consists of three levels of control – technological (or 'operative'), MIS and executive – from the control strategies and power allocation point of view, it allows selection technologies and software more convenient for realization.

Keywords: Product Design; Product Development; Mechatronics; Control Strategies; Walker Robots.

1. INTRODUCTION

The strategies of controlling mobile robots' drives aren't always perfect in their tasks. At the same time efficiency and manufacturability of those strategies could be improved by dividing the system into control levels.

2. TRADITIONAL CONTROL SCHEME

The traditional control scheme corresponds to the following: robot control system can be designed as one control device – microcontroller or fully functional on-board PC – and separate MC's for engines. All control channels are bound to control device: sensors' output channels, inputs from operator's console, device outputs to mechanics and electronics of the platform. The redundancy of such system lies in two points:

- Operator's console. Often the PC is used for console – computer works mostly as plain buffer between operator and bot, so capacities of PC are being idle, working only with operation system.
- Controller powers. Controller manufacturers design their devices with certain capacity. And if single MCs used for 'light' systems allow relatively sharp selection of MC output, more powerful devices contains far more reserves than required.

Traditional control scheme could be improved relatively to its tasks.

3. CONTROL LEVELS

The idea of dividing systems into control levels is known for a long time and has been successfully applied in economics, administration, military art and is universal enough for using in mechatronics and robotics. The system comprises three control levels: strategical, tactical and operative. Physical system separation into those levels allows:

- to lower required capacity of each control device of each level;
- to lower required capacity and maximal capacity of the system;
- to overcome a processing power limit of supplied control devices;
- to design control structure as multifunctional unit-type system with high degree of element interchangeability.

For successful solving the task of lowering essentially processing power, and due to mechatronics' principles, it’s reasonable to physically separate all modules including feedback and engine control to different devices. This should allow realization of multilevel system, which has the listed advantages.

Here is the list of control levels, presented according to their task aggregation:

Technological level, as lowest control level deals with process data collection and processing, produces the control response and sends the data to higher level. But in suggested scheme it could be called ‘operative’ due to availability of independent periphery control functions. Operative block is bound directly to controlled devices, transmitters, power-transforming devices, sensors etc. The block processes higher level’s queries, which are built in the way independent from periphery conformed to block, and submits ‘to top’ data received from feedback devices.

Management Information System control level is subsequent development of central control device of traditional scheme. Block is concentrated on solving tactical task solving: supporting the manipulators (or legs – depending to their task) interaction, feedback interaction, building motion schemes and so on.

Executive control level, as a top level should use the exceeding powers of PC. The spectre of assigned tasks: cartography and navigation, visual recognition, device diagnostic, changing control schemes ‘on the fly’ etc.

4. CONCLUSION

Suggested control scheme, which consists of three levels of control – technological (or ‘operative’), MIS and executive – from the control strategies and power allocation point of view, allows selection technologies and software more convenient for realization. The scheme also allows to simplify construction in common.

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Development of multilevel control system for mechatronic modules of walker bot

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Abstract

The concept of multilevel control system is attractive for designing unit-type or non-standard systems, e.g., walker chassis. The system receives the maximal movement freedom on rough terrain possible for surface transport along with advantages of relatively simple control.
The designed model of mechatronic modules system for walker bot contains three control blocks: top, middle and low level. Low level is transforming mid-level commands, correcting the input data for servocontrollers with necessary adjustments and formatting that data in the required way. Middle one takes the information from operative level, implementing the horizontal aligning of platform, correcting motion schemes and 'talking' to top level. Top level has task of platform movement, navigation, motion scheme task.
The control system had been simulated in Labcenter Electronics Proteus. Physical model is realized on PIC16 family controllers from Microchip Technology Inc. This is done due to their optimal combination of fail-safety, processing power and their wide range of device models – this allows choosing power in proportion to control levels' needs. System had been created on the basis of mechatronic approach. Usage of this model is limited only by the degree of modifiability/suitability of system's interface and modules' potential. This model can serve as a basis for development of many robotic devices.

Keywords: Product Design; Product Development; Mechatronics; Control Strategies; Walker Robots.

1. INTRODUCTION

The concept of multilevel control system is attractive for designing unit-type or non-standard systems, e.g., walker chassis. The system receives the maximal movement freedom on rough terrain possible for surface transport along with advantages of relatively simple control.

2. MODEL'S ESSENCE

The designed model of mechatronic modules system for walker bot contains three control blocks responsible for their control levels: top level (strategical control), mid-level (tactical control) and low level (operative control).

'*Operative' (or Technological) control* is implemented with intermediary MC PIC16F887, which is transforming mid-level commands, correcting the input data for servocontrollers with necessary adjustments and formatting that data in the required way. MCs PIC16F84A perform the function of servocontroller for four drives in four motion modules. There's also sensors module on low-level, which has PIC16F887 as intermediary controller.

Management Information System level is designed as module, which receives the information from operative level, implementing the horizontal aligning of platform, correcting motion schemes and 'talking' to top level. Realization is implemented with PIC16F887 MC.

PC along with transmitter modules forms *executive control level*. This level solves common tasks: task of platform movement, navigation, motion scheme task etc.

The control system had been simulated in Labcenter Electronics Proteus. This program allows show links between MCs precisely. Choise of PIC16 family controllers from

Microchip Technology Inc. had been done due to their optimal combination of fail-safety, processing power and their wide range of device models – this allows to choose power in proportion to control levels' needs.

This structure allows to lower requirements to processing power of mobile part of robot, and this involves an economical effect, which is revealed as opportunity to lower platform price.

3. MODEL'S APPLICATION

Usage of this model is limited only by the degree of modifiability/suitability of system's interface and modules' potential. Particularly, system designed according to model can work in the area of interest of military structures, or as helper equipment for emergency situations, if there're corresponding modules.

The system tuning for needed control ways goes very fast in relation to full bot reprogramming. Any module supporting the command interface could be embedded in the system, if scripts or programs of top level are modified in the right way. Modifying is required due to the absence of self-modification of the model, and allows processing extra data associated with inserted into system modules.

4. CONCLUSION

Therefore, the model of mechatronic modules system had been created on the basis of mechatronic approach. This model can serve as a basis for development of many robotic devices, for fine-tuning algorithms of moving on rough terrain, for modeling and constructing mechatronic modules.

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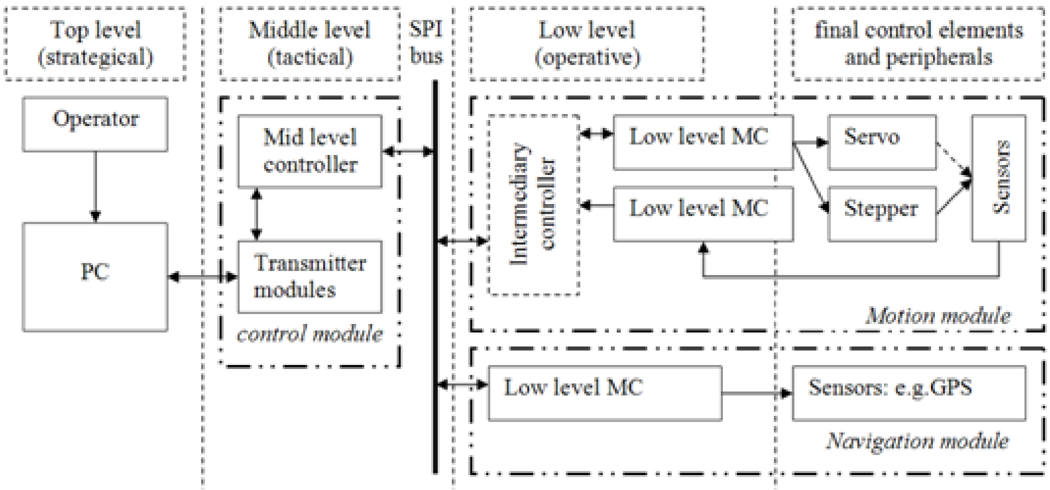

Fig. 1. Control levels scheme

Concept of on-line manual assembly workstation analysis

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Abstract

In the assembly are often used manual workstations. Various method can be used to quality and productivity increasing. The paper describes developed concept of on-line analysis of manual assembly workstation based on using of sensors and appropriate hardware and software equipment. This concept allows in real time to obtain data and transfer them to computer for analysis. After finishing and testing this concept will be dispose a modular analytical tool for manual assembly workstation analysis from the point of view time, failure, etc.

Keywords: Production engineering; Manual assembly; Workstation; Analysis.

1. INTRODUCTION

Modern approaches in manufacturing and assembly technologies [1] are oriented also in the CAx support [2], simulation [3,4] and in structure planning [5]. The most of this are realized for purpose of productivity and quality increasing [6,7]. Nowadays all modern manual assembly workstations are equipped with different types of sensors that monitor and control the assembly process [8]. They are assigned also for proper assembly process execution, for check prescribed assembly operation parameters, for obtaining an information about the state of checked equipment, blocking of operation execution in the event of a fault or incorrect parameter setting, incorrect tools, fixture etc. These sensors are a part of a complex assembly workstation and serve primarily to ensure the quality of the final assembled products. When they are used to assembly process control and evaluation than on the requirement will be created special software designed just for this particular application.

2. CONCEPT OF ON-LINE ASSEMBLY WORSTATION ANALYSIS

The concept of the on-line manual assembly workstation analysis assumed equipping of the manual assembly workstation by sensors. In principle it is possible to have manual assembly workstation without sensors or with sensors. The concept of on-line analysis assumed the installation of new sensors or using existing sensors in the workplace or a combination of these possibilities. Information from these sensors will be used to monitor the assembly process, where the main monitored and evaluated parameters will be the operation sequence, time, product defects and equipment failures. The basic requirement for the development of this model is module structure that e.g. the possibility to use for any workplace and any types of sensors, and the possibility of using alternative inputs for analysis and the creation of a simulation module, that can using of the results of video analysis. The basic concept is shown in Fig. 1.

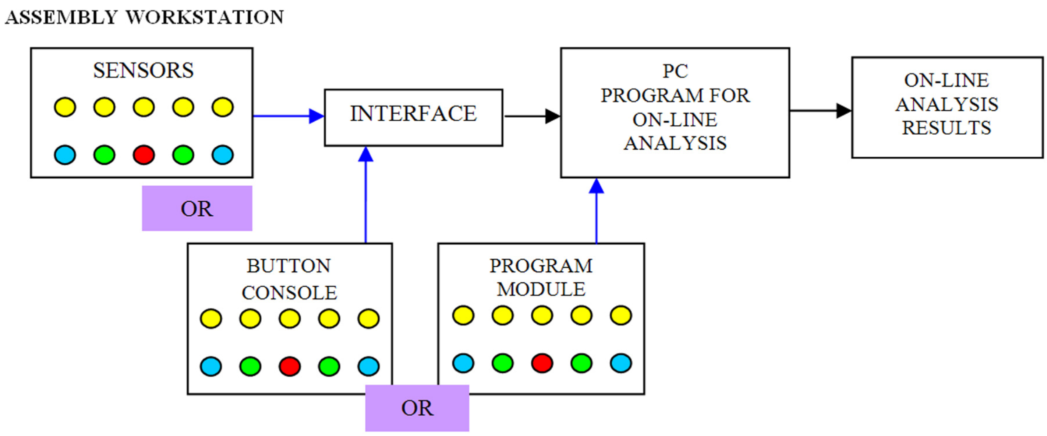

Fig. 1. The basic concept of on-line analysis

The inputs for the analysis are data from 10 sensors located at the manual assembly workstation. Alternatively, these data can be obtained from button console or from a special program module. These inputs can be used mainly in laboratory conditions or where is for the analysis available only a computer model of the assembly workstation.

Based on data from the sensors respectively from simulated sensor activities is possible to execute the analysis by special software and the results can be presented in different ways.

3. HARDWARE AND SOFTWARE

The basis of this concept is an elaborated hardware and software module [9].

3.1. Hardware

The hardware is designed by an interface for reading sensor signals and signal conditioning and subsequently for signal transmission into the computer for further processing. Another hardware module is a button console (Fig. 2) connected to the interface instead sensor bus. Button console output provides from a hardware point of view identical output signals as sensors with binary outputs.

In the case when each assembly workstation is equipped with sensors and has a separate control module type SIMATIC PLC for control of devices and other mechanized parts the sensors can be divided into two groups. One group of sensors is leaded by the bus directly into the interface and the second group of sensors is used as input signals for control modules SIMATIC while their outputs are leaded the bus for connection with the interface unit, where the signals processed for connection to the personal computer. Interface communicates with computer via parallel port. Scheme of interface is shown on Fig. 3.

Fig. 2. Computer and button console with interface

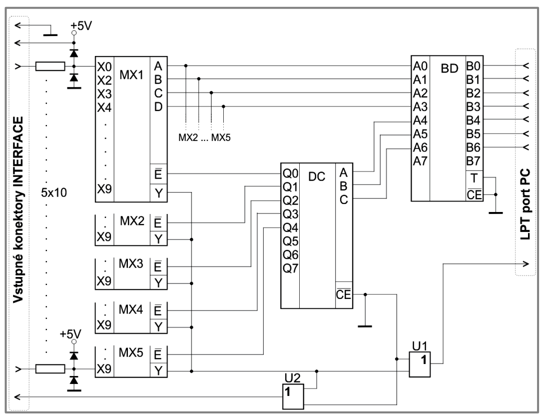

Fig.3. Scheme of connection

3.2. Software

The software is created in a development environment Microsoft Visual Studio 2008 programming language Microsoft Visual Basic. NET.

On the figure 4 are presented some software screens for On-line manual assembly analysis. The figure 5 presents analysis results in the graph form.

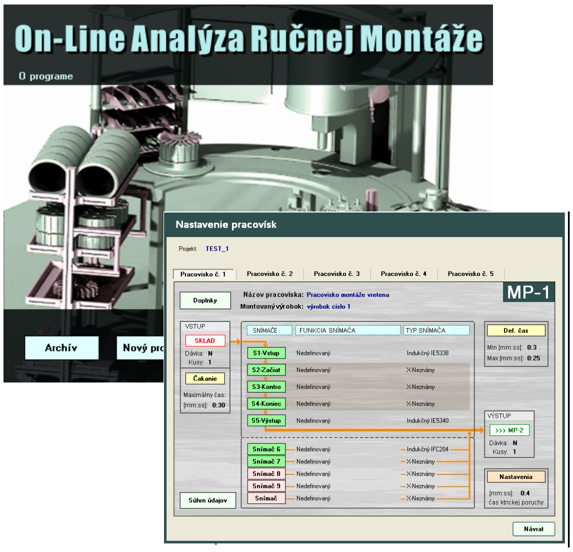

Fig.4. On-line analysis software screens

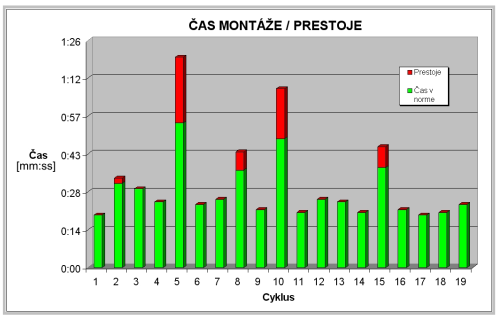

Fig. 5. Analysis results in the form of graph

In this case, was solved a complex problem so, that in addition to on-line analysis in the real environments can the analysis be realized also in the laboratory respectively on the base of 3D model or video analysis. Attention is paid to verification and connecting with the analytical simulation model. Results based on the same concept can thus be obtained even if exists different input data. The figure 6 illustrates a 3D model of manual assembly workstation and the software buttons for sensor input simulation.

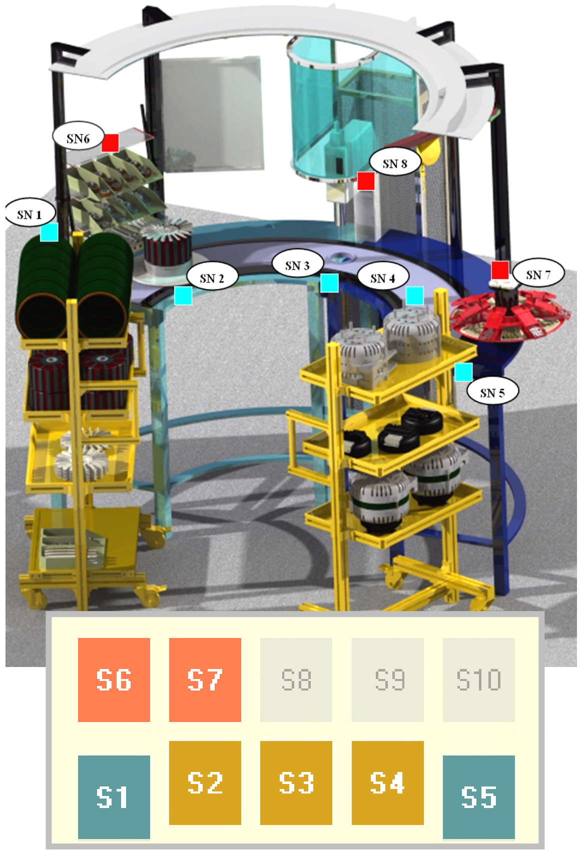

Fig. 6. 3D model of manual assembly workstation and software input of sensors signals

4. RESULTS AND ACHIEVEMENTS

The first results of the on-line analysis indicate that the proposed concept is an original, proper operating and modular solution. The proposed system was created with respect to simplicity, flexibility of use and the possibility of further extension. To construct the peripheral devices have been used commercially available components and to developing of these devices used as standard measuring devices and instruments.

The software module can be modified and extended. From the point of view the whole concept is now solved the connection with video analysis results. Also is solved the analytical simulation module. The main problem in this case is to keep the uniform procedure in all proposed ways of analysis.

Further interesting of extending is the comparison of the results obtained by different way eventually creation of references for simulation module on the base of real data (as is the probability of failure occurrence etc.) obtained in the practice.

5. CONCLUSIONS

Using of designed concept of on-line analysis can help to achieve and hold quality and productivity. Modularity allows use hardware and software at any kind of manual assembly workstation. In future is expected expanding number of sensors which will be able sending data to interface and also creating of simulation software which will predict behavior of real workstation and by this way will be able design more reliable manual assembly workstations.

6. ACKNOWLEDGEMENTS

This contribution is the result of the project implementation: Center for research of control of technical, environmental and human risks for permanent development of production and products in mechanical engineering (ITMS: 26220120060) supported by the Research & Development Operational Programme funded by the ERDF.

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The influence of spin casting parameters on running property of zinc alloy ZnAl4Cu3

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Abstract

Paper deals with influence of mould rotation speed, casting temperature and clamping pressure during spin casting into silicon moulds on running parameter of zinc alloy castings. The rotation speed is in range 200 – 500 rpm. The casting temperature in range 420 - 430 °C and clamping pressure in range 45 – 55 PSi. The results of experiments are curves of rotation speed, casting temperature and clamping pressure on running property of zinc alloy.

Keywords: Centrifugal casting; Zinc; Running property; Silicon.

1. INTRODUCTION

The spin casting technology belongs to casting technologies, which utilize the centrifugal force to fill the mould cavities by molten material. The centrifugal force is generated by mould rotation [1].

Spin casting is the technological process to produce metal, plastic and wax parts quickly from an existing master model [2]. It is especially suitable for the manufacture of die casting parts since the manufacture of dies is normally very time-consuming and expensive. The workshop of spin casting into silicon moulds contains the hydraulic vulcanizer, melting furnace and electronically controlled casting machine.

Teksil silicone rubber mould material, enables the casting low melting point alloys, especially zinc, tin and lead alloys, for thin walled and small castings also aluminium, some types of plastics and wax. [3]. Silicone rubber is a flexible material before vulcanizing; it can be easily formed around the master model. Mould manufacture is fast and easy. Casting mould can be produced per one day [4].

This technology is also used as effective replacement of rapid prototyping technologies. Castings cast by spin casting are very precise, with clean surface and with minimal requests to next treatment. Spin casting technologies allows casting high precision structural parts, not only artistic castings and jewellery.

2. METHODS AND MATERIALS USED FOR RESEARCH

During experimental process was observed the influence of mould rotation speed, casting temperature and clamping pressure on running property of zinc alloy ZnAl4Cu3. In Fig. 1 are shown the patterns, formed by bending machine Unicorn XJZM 1000/3, used for experimental mould manufacturing. Pattern diameters were 6, 4 a 3 mm.

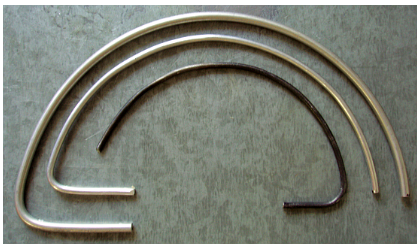

Fig. 1. Patterns used for experimental mould manufacturing

Angle, between each pattern was 5°. Places of moulding of each pattern are shown in Fig. 2. One set of patterns were moulded in direction of molten metal flowing (rd) and other set in counter direction (cd).

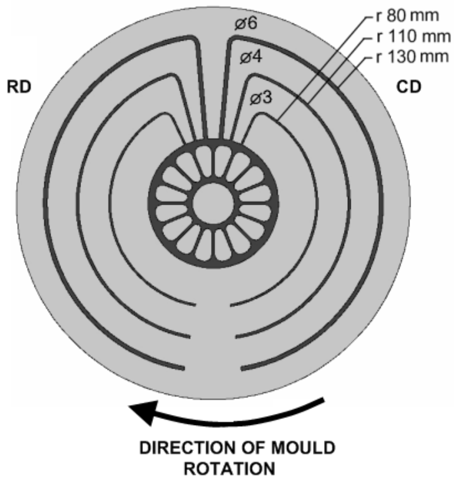

Fig. 2. Locations of patterns in experimental mould

Silicon rubber White SD THT with diameter 15” was used for experimental mould manufacturing (Fig. 3).

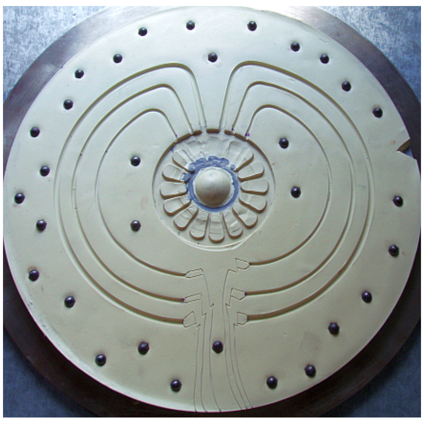

Fig. 3. Experimental mould

In Digital hydraulic 3-post vulcanizer – 50 TON/EA was vulcanized the experimental mould and the time of vulcanization was 80 min. Pressure of vulcanization process was 4500 PSi and vulcanization temperature 170 °C.

Experimental castings were cast by Tekcaster Series 100D casting machine. Cast material was zinc alloy ZnAl4Cu3, the chemical composition is shown in Table 1. Casting temperature of zinc alloy during casting process was established to 420 °C, 425 °C and 430 °C.

Table 1. Chemical composition of zinc alloy ZnAl4Cu3

ZnAl4Cu3 (EN 12844)	Al	Cu	Mg	Pb	Cd
	3,7 - 4,3	2,7 - 3,3	0,025 - 0,6	max. 0,005	max. 0,005
	Sn	Fe	Ni	Si	Zn
	max. 0,002	max. 0,05	max. 0,02	max. 0,03	rest

Clamping pressure was established to 45 PSi; 50 PSi and 55 PSi. For each value of clamping pressure, the mould rotation speed was set in range from 200 rpm to 500 rpm, with step 50 rpm. Time of casting process was 30 seconds.

3. RESULTS AND ACHIEVEMENTS

Experimental castings were weighed and the percentage filling of mould cavity by zinc alloy was calculated, for each combination of analyzed parameters. According calculated values were designed the particular dependencies. In Fig. 4 are shown the dependencies of running property on clamping pressure and rotation speed, at constant casting temperature 425 °C.

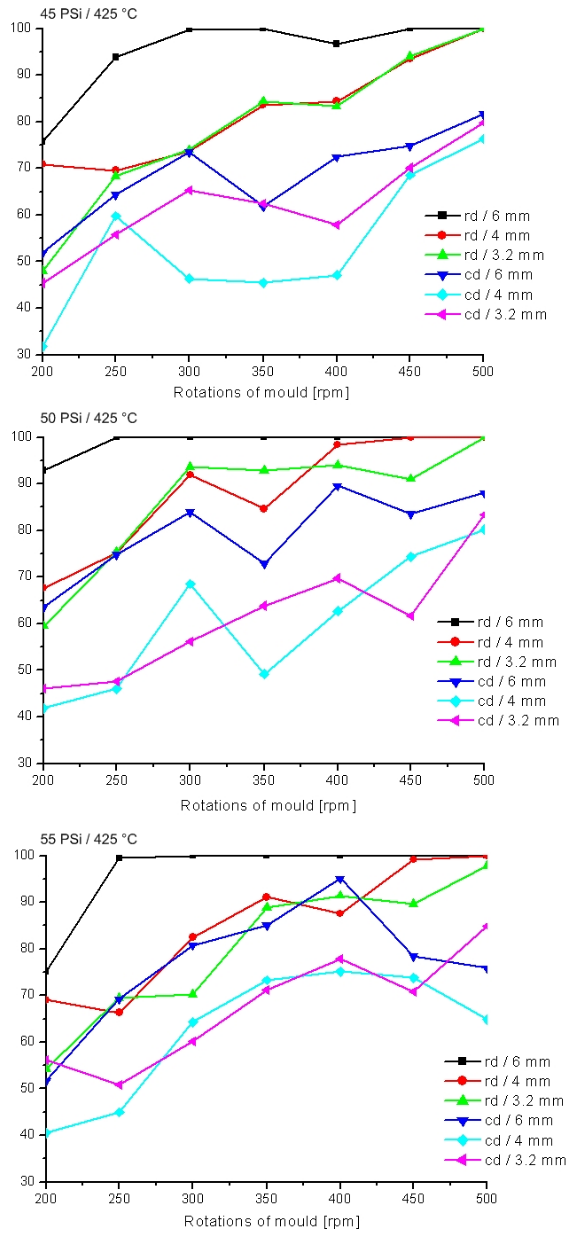

Fig. 4. Dependencies of running property on rotation speed and clamping pressure

From Fig. 4 is obvious that by increasing of clamping pressure to 50 PSi increased the running property. Increasing of clamping pressure from 50 PSi to 55 PSi caused small decreasing of running property.

For RD placed casting and 6 mm diameter of casting at 45 PSi, the running property achieved 100 % at rotation speed in range from 300 rpm to 500 rpm. For CD placed casting achieved the maximum of running property about 80 % and was in range from 50 to 80 %. The running property of RD castings with diameters 4 and 3,2 mm achieved 100 % only at 500 rpm. At CD castings with diameters 4 and 3,2 mm acchieved the maximum of running property only about 70 %.

By increasing of clamping pressure to 50 PSi increased the running property slightly. For RD casting with 6 mm diameter the running property achieved 100 % already at 250 %. Also for RD casings with diameters 4 and 3,2 mm was observed significant increasing of running property, over 300 rpm. For CD castings was not observed significant effect of changing of clamping pressure.

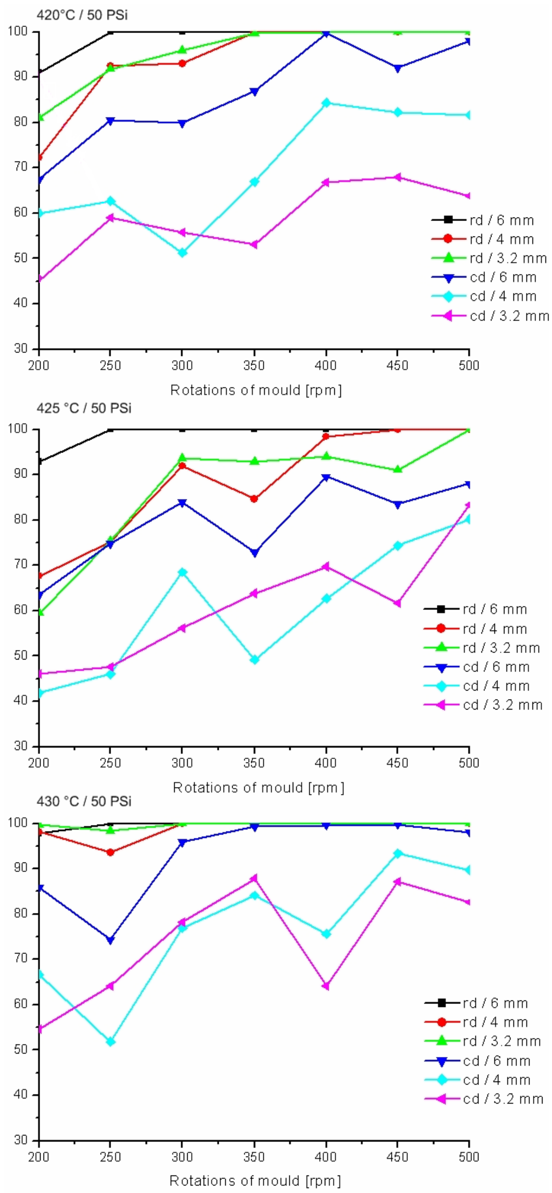

Fig. 5. Dependencies of running property on rotation speed and Casting temperature

Increasing of clamping pressure to 55 PSi caused minor changes of running property. The changes related only the small decreasing of running property at lower rotation speeds and for CD castings as well as over 450 rpm.

More evident is the effect of increasing of casting temperature, shown in Fig. 5. Fig. 5 shows the dependencies of running property on casting temperature and rotation speed, at constant clamping pressure 50 PSi.

The process of increasing of running property, by increasing of rotation speed, is very similar at casting temperatures 420 °C and 425 °C. At casting temperature 430 °C achieved the running property higher values. The effect of higher casting temperature is evident. The running property of RD castings achieves over 95 % already at low rotation speeds. In range from 300 rpm to 500 rpm achieved 100 %. For CD casting with 6 mm diameter achieved the running property about 95 % at 300 rpm and increased to 100 %. At 500 rpm slightly decreased. Also the increasing of running property for CD castings with 4 mm and 3,2 mm diameter was observed, however at 500 rpm also slightly decreased. In this case, the running property achieved the range from 80 to 90 %.

It's possible to see the difference between castings placed in direction of molten metal flowing and castings placed counter direction. This difference is as a result of effect of Coriolis force. Coriolis force pushed the molten metal counter direction of mould rotation [5].

4. CONCLUSIONS

According to producer manual, the most optimal clamping pressure for mould with 15" diameter is 45 PSi and casting temperature of ZnAl4Cu3 alloy is 420 °C. From the results can be concluded that the most optimal value of clamping pressure for mould with 15" diameter is 50 PSi. The results show also that the change of running property is evident by changing of casting temperature. In this case the results show that the most optimal casting temperature is 430 °C.

At clamping pressure 50 PSi and casting temperature 430 °C achieves the running property of 6 mm RD casting the value 100 % already at 250 rpm. For same casting and 200 rpm achieves the running property about 98 %. Also for RD castings with diameter 4 mm and 3,2 mm are the values of running property highest. In this case achieves the running property 100 % at 300 rpm. That is about 10 % increasing of running property over 300 rpm as in case of lower temperature.

5. ACKNOWLEDGEMENTS

The financial support of grants from the Ministry of Education of the Slovak Republic VEGA 1/0383/10 is gratefully acknowledged.

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Electrolytic–plasma polishing in electrolyte

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Abstract

This paper deals with a new polishing technology of the metal surfaces, with electrolytic-plasma polishing. The subject of the paper is the influence of treating time on desired properties of the treated surface. A specimen of stainless steel DIN 1.4404 has been used for experiments. All of the process parameters were kept constant during the polishing: temperature of the electrolyte, voltage between electrodes, concentration of the electrolyte as well as the immersion dept of the specimen in the electrolyte.

Keywords: Electrolyte; Plasma discharge; Stainless steel; Polishing; Water-steam film.

1. INTRODUCTION

The polishing of stainless steels is applied in the industry, mainly due to corrosion resistance increase of surface and due to reduction of the surface roughness. Polishing is the most often used surface finishing operation in the medical, food or chemical industry. The corrosion resistance improvement is not the only benefit of the polishing, but the surface becomes smoother and more resistant to dirt, bacteria, mold, etc. Electrolytic-plasma polishing removes defects of metal surface and burrs, as well. Except all these properties, the technology increases the gloss of the metal surface [1], [2].

The technology is based on physical phenomena, occurring on the treated surface of metal part to be treated, which is immersed into the electrolyte and is connected to the plus pole of the electric current supply. The treated part is the anode. The second electrode is connected to the minus pole of power supply (Fig. 1). So the principal scheme is similar to the common electro-chemical polishing. Due to high voltage between electrodes a water-steam film is formed on the entire treated surface. The film is electrically non conductive and it separates the metal surface from the electrolyte. In this way the electric current is broken so the electric circuit is disconnected. If the voltage between the electrodes is high enough, the water-steam film becomes ionized. Due to high electric field, electric current flows through the water-steam film in the form of glow discharge. Plasma discharges act on the metal surface in this polishing process. The discharge runs toward the micro surface "peaks" in the form of thin columns, in places where is the distance of the water-steam film between the treated surface and the electrolyte smallest, heating up and vaporizing the surface of the metal. The discharge last short time, material of surface vaporizes and then the discharge runs to another place. In this way the surface becomes smoother. If a proper chemical composition of the electrolyte and suitable parameters of the process are used, the treated surface becomes glossy [1].

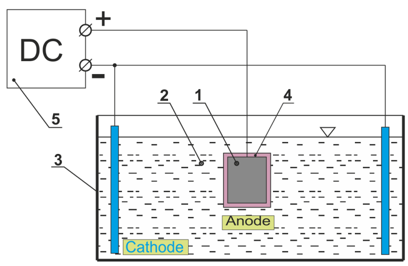

Fig. 1. Principal scheme of the process

1 Treated specimen
2 Electrolyte
3 Work vessel
4 Ionized water-steam film
5 Power supply

2. RESEARCHES

2.1. Specimen

The experiment deals with the study of the influence of the treating time at electrolytic-plasma polishing on the surface roughness, the gloss level and ablation of the surface material. A machined industrial component has been used as a specimen during experiments (Fig. 3). The part was made from austenitic stainless steel DIN 1.4404.

2.2. Experimental procedure

The studied properties of the metal surface were measured before and after polishing. Each the polishing step lasted 30 seconds. The specimen was treated 7 times, so the total time of the treating was 4.5 minutes. The surface properties were measured always on identical places, as it is described below. The parameters of the process during polishing were kept at constant values: the voltage was always the same and the immersion dept of specimen was 50 mm. The specimen was polished in the electrolytic solution NRZ1 of concentration 6 % at temperature 70 °C.

2.3. The surface roughness

The decrease of the surface roughness is usually the most important result of polishing. Digital portable surface roughness tester TR – 200 was used for roughness measuring (Fig. 2).

Fig. 2. Apparatus TR – 200

Measurement of the roughness was made on eight areas, marked from A1 to A8 (Fig. 3). Resulting values are shown in the Table 2. A regression analysis of the experimental data has been carried out using software Golden Grapher version six.

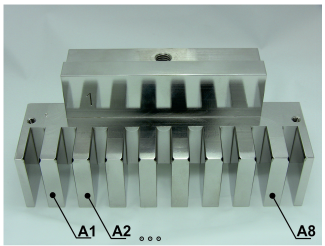

Fig. 3. Measured areas

2.4. The surface gloss level

The gloss-meter NOVO CURVE (Fig. 4) has been used for exact assessment of gloss level of the surface. The measured areas are similar as it was described in previous part (Fig. 3). The apparatus was connected to the computer and each measured value was recorded into the Table 2. The graphic characteristic (Fig. 7) was made from an average value of gloss for each time step.

Fig. 4. The gloss-meter NOVO-CURVE

2.5. Measurement of the material ablation rate

The material removal was evaluated as the change of the size on the measured points. The measured points were on two sides of the parts of the sample P1, P2, P7 and P8. Each part had three measured points a, b, c (Fig. 5).

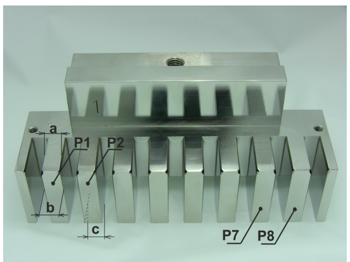

Fig.5. The measured points dimension of the sample

Table 1. The measured and calculated values of the surface roughness

Treating time [s]	The surface roughness [μm]								
	A1	A2	A3	A4	A5	A6	A7	A8	Average value
0	0.391	0.291	0.379	0.238	0.278	0.393	0.310	0.346	0.328
30	0.374	0.234	0.239	0.211	0.199	0.229	0.242	0.270	0.250
60	0.236	0.223	0.208	0.198	0.183	0.209	0.232	0.235	0.216
90	0.212	0.209	0.198	0.188	0.178	0.172	0.191	0.223	0.196
120	0.202	0.199	0.190	0.173	0.158	0.174	0.191	0.201	0.186
150	0.192	0.168	0.180	0.157	0.151	0.181	0.175	0.186	0.174
180	0.181	0.165	0.180	0.153	0.146	0.167	0.188	0.193	0.172
330	0.141	0.144	0.159	0.133	0.123	0.154	0.150	0.142	0.143

Table 2. The measured and calculated values of the surface gloss level

Treating time [s]	The surface gloss level								
	A1	A2	A3	A4	A5	A6	A7	A8	Average value
0	66.1	74.6	66.7	86.5	75.4	69.4	57.9	71.5	71.0
30	222.2	244.7	274.4	257.7	223.1	268.4	250.7	227.1	246.0
60	389.4	391.1	425.4	402.2	399.4	395.5	389.7	376.7	396.2
90	469.6	481.0	490.2	464.2	471.0	457.9	461.1	461.4	469.5
120	503.3	510.2	506.2	493.2	497.2	495.1	492.2	501.4	499.8
150	546.9	549.5	553.1	549.0	519.1	537.3	531.2	542.8	541.1
180	578.4	567.3	568.3	568.0	564.7	541.2	566.4	565.7	565.0
330	634.2	631.1	627.1	627.1	622.8	624.4	625.6	621.4	626.7

Table 3. The material ablation dependence on treating time

Treating time [s]	P1			P2			P3			P4			Average value
	Δ***a*** [μm]	Δ***b*** [μm]	Δ***c*** [μm]	Δ***a*** [μm]	Δ***b*** [μm]	Δ***c*** [μm]	Δ***a*** [μm]	Δ***b*** [μm]	Δ***c*** [μm]	Δ***a*** [μm]	Δ***b*** [μm]	Δ***c*** [μm]	[μm]
0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	4	8	7	0	4	3	6	6	2	2	3	3	4
60	12	12	9	6	7	5	9	10	5	4	7	4	8
90	13	13	11	6	8	6	11	11	6	6	8	5	9
120	14	14	15	5	10	8	13	14	9	9	10	7	11
150	16	15	15	9	12	10	16	16	9	10	12	10	13
180	17	18	17	10	14	13	16	17	11	11	17	16	15
330	21	22	21	15	20	18	20	26	20	17	23	21	20

3. RESULTS

3.1. Result of the decrease surface roughness with time

As it can be seen, the surface roughness decreased logarithmically (Fig.6). This decrease is at first massive, but after a time it is slowed. Therefore the long time of polishing has not brought a significant effect. For example the surface roughness decreased after first 90 seconds from Ra = 0.328 μm to 0.196 μm and this is 41 % of the primary value. After next 90 seconds of treating, the surface roughness decreased from 0.196 μm to 0.172 μm and this is only 12.2 % of the previous value. The minimum theoretical roughness is delimited by the size of grain of a treated material, as it is described in [1].

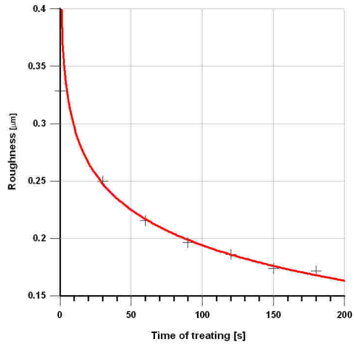

Fig. 6. The decrease of roughness

The equation obtained by the regression analysis has a form:

$$R = (-0.045) \times \ln T + 0.4 \quad (1)$$

Where T – is time of treating in seconds

R – is the final roughness of the surface [μm] after time of treating T

3.2. The surface gloss level increase

As it can be seen on Fig. 5, the gloss level increased by the time, but the course is nonlinear. The change of the gloss was the most intensive just after the beginning of the treatment. The surface gloss increased and changed by the equation (2). The equation was obtained by the regression analysis of measured values using the third polynomial degree.

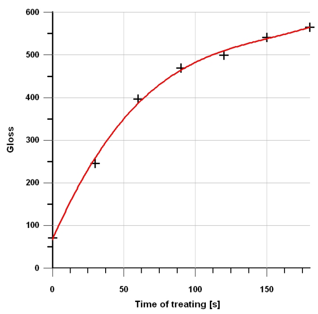

Fig. 7. The change of surface gloss level

$$G= 66.9 + 7.7 \times T - 0.045 \times T^2 + 9.8x10\text{-}5 \times T^3 \quad (2)$$

Where T – is time of treating in seconds

G – is the surface gloss level after time of treating T

3.3. Result of the material ablation

The calculated values of material ablation are given in the Tab. 3. Each value represents the dimension difference before and after the treatment step. The material ablation increased and changed by the equation (3).

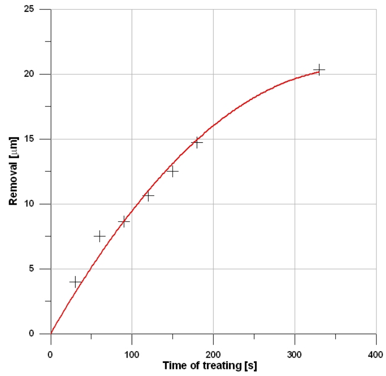

Fig. 9. The material ablation

$$R = 0.11 \times T - 1.47x10^{-4} \times T^2 \quad (3)$$

Where T – is time of treating in seconds

R – is the material ablation after time of treating

4. CONCLUSIONS

The results of measuring were confirmed assumed of hypothesis. The polishing process had a positive effect on surface properties (roughness, gloss). The surface roughness decreased and the gloss of surface increased. The change of parameters was not linear, but change was a curve (logarithmic, n grad polynomial). Minimum roughness of the surface is process limit, due to the size of the grain material given. We can assume, than other similar steels as DIN 1.4404 will have comparable results of gloss and roughness reach. Gloss of the surface decreased for other steels with the rising concentration of carbon [1].

In the future we will study influence of the process parameters and surface properties on the corrosion resistance of the polished samples. We will also study and compare the polishing results of the surface properties between electrolytic–plasma polishing in electrolyte and electrochemical polishing in electrolyte for other materials.

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FEM simulation of hard cutting

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Abstract

The ever wider application of hard machining procedures indicates their importance among mechanical engineering procedures. Based on the research results it can be stated that their role may further increase. From our FEM investigations of hard turning done by geometrically defined edges, this paper outlines the effect of the flank wear change in the cutting tool.The experiments were made on case hardened steel (AISI 5115) with 62±2 HRC hardness at different values of cutting speed and feed. The phenomena of adiabatic shear accompanied by the "sawtooth" chip formation as well as the effect of the cutting data a plastic strain. The change of the morphology of chip formation is compared depending on the cutting speed and tool flank wear.

Keywords: Production engineering; Hard turning; Chip morphology; Flank-wear.

1. INTRODUCTION

Studying the chip removal process always appears as a significant task for researchers. The complicated processes emerging in material separation influence both the load on the tool and the quality of the machined surface in a determining way in any tool material and workpiece material pairing. The change of the tool wear influences the quality of the machined surface. Its importance is highlighted in finish machining since the values of roughness and accuracy prescribed in the drawing of the component are ensured in this process. These values suit the precision (often ultraprecision) machining. In engineering the increase of wear resistance and the life of the tools is of great importance, therefore, attention must be paid to the selection of cutting data in finish machining.

In the case of steels one of the conditions of the increase of wear resistance is to increase the number of hardened surfaces (>45 HRC) on the components. The different processes of the machining of hard surfaces are called hard machining. Today the two most frequent processes are: grinding and turning. Hard turning is to replace grinding by which surfaces were earlier machined. Thus, mostly the goal is to provide the accuracy and roughness on hard turned surfaces that can be reached by grinding.

Partly this is successful because the turning of the hardened materials in the case of several surfaces/parts (e.g.: disc type parts) replaced the machining used before.

The load on the tools first of all PCBN inserts used in cutting materials of high hardness is increased. The number of the used up PCBN inserts is dramatically growing because the number of the parts having hard surfaces, built in the products is continuously grooving.

This paper deals with the FEM investigation of some process characteristics of hard turning done with geometrically defined edges. In hard turning the removed chip has a special morphology. This morphology is called "sawtooth" in the special literature [1, 2, 3].

The chip formation mechanism is the result of the following effects: the mechanical, thermal, thermomechanical properties of the material; the cutting conditions; the divergence of shearing in the primary zone; the tribological relationship between the face of the tool and the rear part of the chip; the possible interactions between primary and secondary shear zones; the dynamic response of the machine-tool structure and its interaction with the cutting process [1].

The machining of hard materials is characterized among others by small chip cross section and relatively high cutting speed and high temperature involved in the chip removal.

This is determining for the cutting process characteristics. Both the results published in technical literature [1, 2] and our investigations indicate that the values of these characteristics depend on the extent of the flank wear.

This paper outlines the effect of the change of flank wear in the case of orthogonal (2D) cutting.

2. FINITE ELEMENT MODELLING OF THE CUTTING PROCESS

The investigation of the effect of the tool flank wear value on the cutting force components (cutting- and passive force) was simulated by the two- dimensional version of Third Wave AdvantEdge™ 5.5 program package, which is optimised for cutting process modelling, therefore several researchers [2, 5, 6, 7, 8, 9, 10, 11, 12] have used this software to simulate metal cutting. The process parameters of the experiment are listed in Table 1.

Table 1. Input parameters of the FEM simulation

Workpiece		Process	
Workpiece length	5 mm	Depth of cut	0.2 mm
Workpiece height	3 mm	Length of cut	3 mm
Workpiece material	AISI 5115	Feed	0.15 mm/rev
Tool		Cutting speed	180 m/min
Rake angle	**-26°**	Friction coefficient	0.35
Rake face length	1.2 mm	Coolant	Not used
Relief angle	6°	**Simulation**	
Relief face length	2 mm	Max. nodes	24000
Cutting edge radius	0.01 mm	Max. element size	0.1 mm
Material	CBN	Min. element size	0.01 mm
Flank wear	0-0.5mm	Mode	Standard

This FEM software uses the Johnson- Cook equation [2, 3, 4], as flow stress model for the workpiece material (AISI 5115) used by us:

$$\sigma_{red} = \left(A + B\cdot e^{n}\right)\cdot\left(1 + C\ln\left(\frac{\dot{\varepsilon}}{\varepsilon_0}\right)\right)\cdot\left(1-\left(\frac{T - T_{room}}{T_m - T_{room}}\right)\right)^{m} \quad (1)$$

Where $\boldsymbol{\sigma}_{\mathbf{red}}$ is the reduced stress, ε is the plastic strain, $\dot{\varepsilon}$ is the plastic strain rate, $\dot{\varepsilon}_0$ is the reference plastic strain rate, **T** is the temperature of workpiece, $\mathbf{T_m}$ is the melting temperature of workpiece material, $\mathbf{T_{room}}$ is the room temperature, coefficient **A** is the yield strength, **B** is the hardening modulus, and **C** is the strain rate sensitivity coefficient, **n** is the hardening coefficient, and **m** is the thermal softening coefficient.

3. SIMULATION RESULTS

In this two- dimensional FEM analysis the increase of the cutting force and the passive force components and the change of the "sawtooth" mechanism are researched depending on the tool flank wear value. The selected results of the FEM- analysis are listed in Figure 1 and Figure 2.

If the value of the flank wear goes higher, the passive force and the cutting temperature will be higher and higher. The highest cutting temperature (≈1400 °C) is near the melting temperature of the workpiece material in case of VB=0.5 mm, and the passive force is near 600 N. This is approximately a value five times higher than that of the sharp tools. Figure 1 presents that the "sawtooth" chip formation disappears, if the flank wear is VB>0.2 mm. The formation of the cutting- and passive force depending on flank wear is presented in Figure 3.

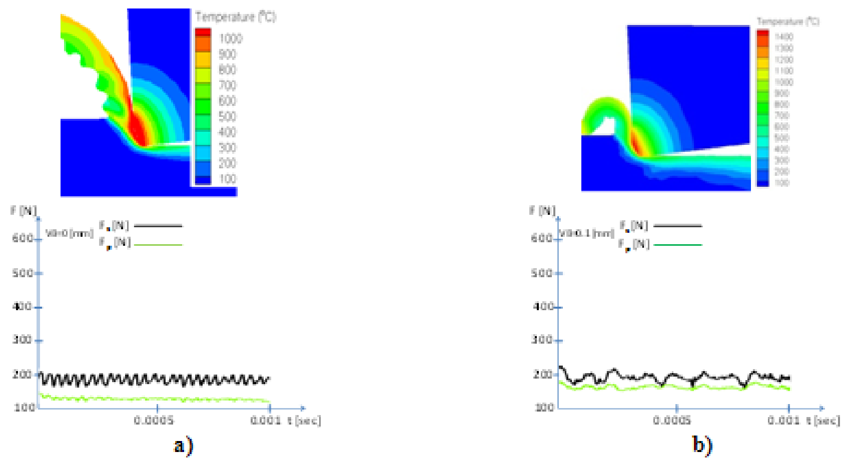

Fig. 1. Connection between the cutting temperatures and cutting force components depending on the tool wear largeness in the case of v_c=180 m/min, a_p=0.2 mm, f=0.15 mm/rev (VB: a=0, b=0.1 mm)

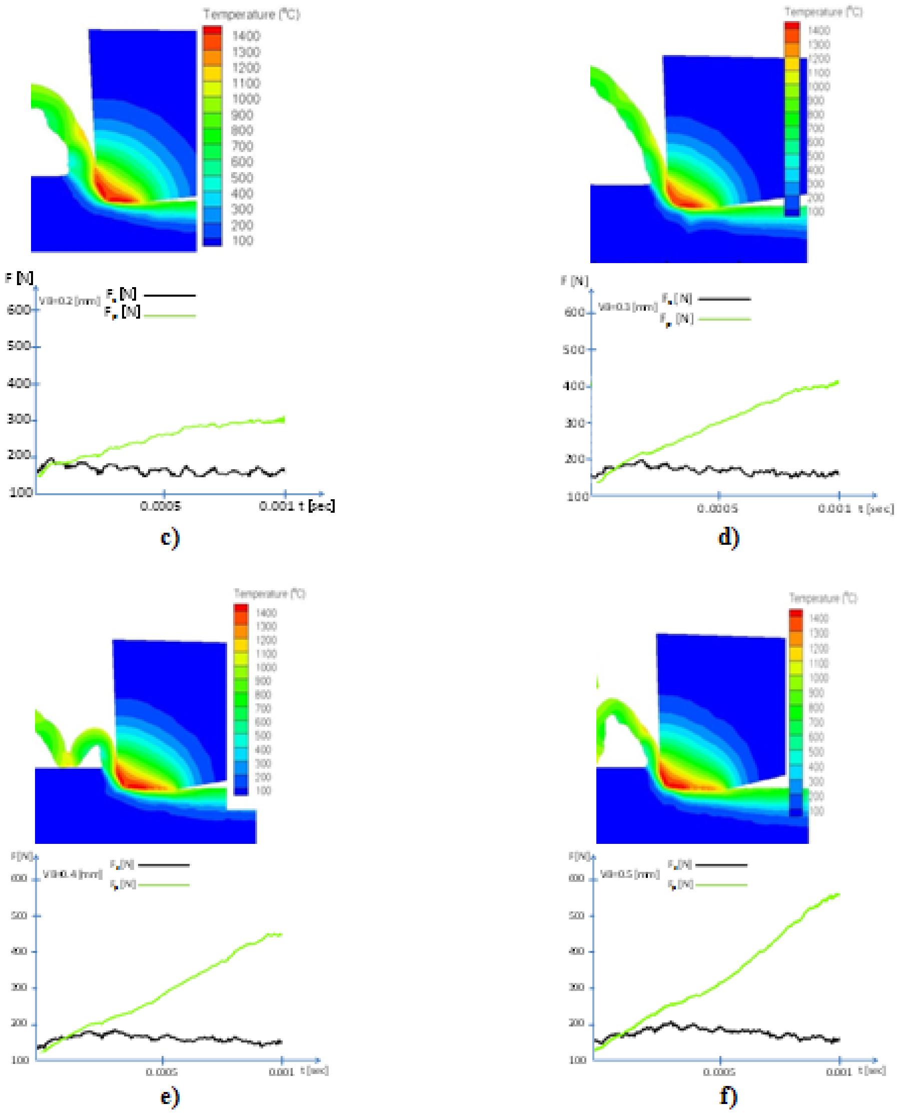

Fig. 2. Connection between the cutting temperatures and cutting force components depending on the tool wear largeness in the case of v_c=180 m/min, a_p=0.2 mm, f=0.15 mm/rev (VB: c=0.2, d=0.3, e=0.4, f=0.5 mm)

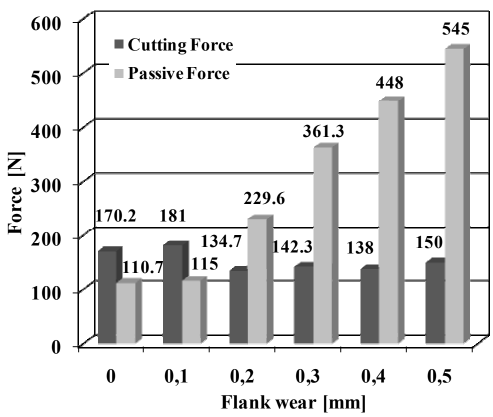

Fig. 3. The values of the cutting force and passive force depending on flank wear

4. CONCLUSION

This paper outlines how by the support of finite element analysis change the cutting force components depending on the tool flank wear values. The change of the passive force component is striking. The passive force does not show up to VB=0.2 mm any significant change. The chip „sawtooth" segmentation mechanism disappears from the flank wear value of VB=0.2 mm. From the increase of this flank wear value the difference between the cutting force and passive force components is bigger and bigger. At VB=0.5 mm flank wear the passive force is almost five times higher of the initial value (492 %) while the main cutting force less than one and a half times more (136 %). It is found, that the flank wear has a significant effect on the cutting results. From VB=0.3 mm the flank wear is harmful to the geometrical accuracy and the surface quality of the machined parts.

5. ACKNOWLEDGEMENTS

The work was presented by the support of the Hungarian Scientific Research Fund (Number of Agreement: OTKA K 78482), which the authors greatly appreciate.

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[11] ČSN 41 4220/ISO 683/11-70

[12] Third Wave AdvantEdge™

Some economic issues of hard machining

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Abstract

The functional requirements of the machined surfaces are higher and higher, therefore the number of hardened surfaces on the components and their hardness, too, has been increasing continuously. The precision finishing of the components having mainly hardened surfaces can be realized by several procedures by now. The paper focuses on the introduction of the economic efficiency of these hard machining processes, grinding, turning and combined procedures.

Keywords: Production engineering; Grinding; Hard cutting; Combined procedures.

1. INTRODUCTION

The machined surfaces have to face higher and higher functional requirements, therefore the number of hard surfaces on the components as well as their hardness increase more and more frequently.

In precision production these components are more and more frequently machined in order to increase their wear resistance and to increase their life. In the manufacturing chain hardening is followed by the finishing that forms the final geometry of the component and provides the quality determining the operation of the component [1, 2].

Hard machining is often applied in finishing, therefore it has a major importance.

Hardened surfaces were machined earlier by different abrasive grains / tools, and by the concrete choice corresponding to the specified geometry, accuracy and surface roughness of the component [3, 4, 5]. The appearing PCBN tools and using them in hard machining opened a new era. By appearing of this alternative procedure, the unfavourable properties of grinding also came into view: it is a slow procedure, relatively expensive and polluting.

Among hard machining operations hard turning has been in the centre of attention for the last decades because it has created new possibilities besides abrasive machining (mainly grinding). Today hard turning processes are fulfilling the requirements concerning the standards of surface roughness and IT accuracy.

The advantages of hard turning as a new operation became emphasised. Because through the developments they succeeded to create production tools (machine-tools, tools, etc.) with accuracy similar grinding, in most cases it became possible to provide the prescribed accuracy, roughness and surface quality when machining by tools with geometrically defined cutting edges. If the requirements for the component can be provided with different procedures, the ice of the concrete procedure is determined by economic aspects.

The major issue of the paper is: what the economic efficiency is of the different hard machining processes providing the quality requirements prescribed for the component.

2. ECONOMIC COMPARISON INVESTIGATIONS

In this paper the economic efficiency of the machining done by grinding, hard turning and by the combination of the two is investigated.

For investigation components were selected which are to be procedure in large number, and which are accurate and reliable in their operation [2]. The chosen workpiece was disc-featured component with bore-hole, more exactly it was a gear-wheel.

Now often all the surfaces of the gear-wheel body of transmission are hardened, so the gear-wheel body itself is ready machined bay hard machining operations.

We investigated grinding, since these hardened surfaces had been machined by grinding earlier.

The other procedure chosen for investigation is hard turning, which provides accuracy and quality of the component similar to grinding.

The application of the so called combined (hybrid) machining was investigated too. The essence of combined machining (multi-processing, hard machining, hybrid machining) is: the two procedures are performed on one machine tool and in one clamping.

To compare these procedures, economic and efficiency indicators were analysed. These were the followings: machining time (MT), surface rate (SR) and material removal rate (MRR).

2.1. Experimental conditions

The experiments were made for gear bore-holes of IT5 accuracy when surface roughness Rz=5 µm was to be provided. Table 1 summarizes the sign and description of the procedures we investigated and the draft of the workpiece.

The data of the workpiece were as follows:

- material: 16MnCr5;
- hardness: 61÷63 HRC;
- diameter: d_1=38;
- accuracy: IT 5;
- length of bore: L_3=29.85;
- ℓ/d relationship: 0.79;
- sequence size: n=200.

From 0.15 mm allowance 0.1 mm were removed by roughing, 0.05 mm by smoothing. The characteristic technological conditions are summarized in Table 2.

2.2. The investigated efficiency indicators

To compare economic efficiency, MT, SR and MRR indicators were investigated. To calculate different theoretical values, the removed surface and/or volume per unit of time have been used for a long time. First of all the possible cutting data of the procedure are used.

Table 1. Draft of the workpiece and the summary of the investigated procedures

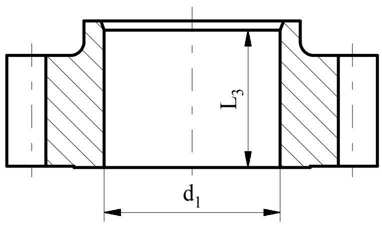
Workpiece	Process			
	Sign	Description	Procedure	
			Roughing	Smoothing
	**A**	internal traverse grinding	corundum wheel	corundum wheel
	B	hard turning	standard insert	standard insert
	C		wiper insert	
	D	combined procedure	standard insert	corundum wheel
	E		wiper insert	

Table 2. Technological conditions of cutting bore-holes

Process		**Grinding**	**Hard Cutting**	**Combined process**
Machine tool / Tool		**SI-4/A** 40x20x16-9A80-K7V22	**PITTLER PVSL-2** CNGA 120408S-LO CBN CNGA 120408 7020	**EMAG VSC 400 DS** CNGA 120408S-LO CBN 40x40x16-9A80-K7V22
Condition data	Roughing	v_c=30 m/s v_w=18 m/min $v_{f,L}$=2.2 m/min	v_c=180 m/min f=0.15 mm/rev. (S+S) f=0.24 mm/rev. (W+S) a_p=0.10 mm	v_c=180 m/min f=0.15 or 0.24 mm/rev. a_p=0.1 mm v_w=14…19 m/min
	Smoothing	v_c=30 m/s v_w=18 m/min $v_{f,L}$=2 m/min	v_c=180 m/min f=0.08 mm/rev. (S+S) f=0.12 mm/rev. (W+S) a_p=0.05 mm	v_c=45 m/s v_w=57 m/min $v_{f,R1}$=0.0033 m/min $v_{f,R2}$=0.0016 m/min a_p=0.05 mm

These indicators are the following:
- material removal rate Q_w (mm^3/s);
- surface rate A_w (mm^2/s).

We investigated these indicators earlier [6, 7] and introduced a corrected (practical) interpretation for the investigation of the procedures to increase the accuracy of the comparison. The practical value of the material removal parameter (Q_{wp}) is calculated in the next context: material volume of the allowance is divided by the time required for its removal.

$$Q_{wp} = \frac{d_1 \cdot \pi \cdot L_4 \cdot 0{,}3}{t_x \cdot 60} \ (\text{mm}^3/\text{s}) \qquad (1)$$

Calculation of the practical value of the surface rate: the size measure of the surface to be machined is divided by the time required for its production.

$$A_{wp} = \frac{d_1 \cdot \pi \cdot L_4}{t_x \cdot 60} \ (\text{mm}^2/\text{s}) \qquad (2)$$

Further investigations of practical parameters proved [6. 7] that they are able to express the efficiency of material removal and they correspond with the real machining times and costs. Our investigations focused on the determination of $Q_{wp,op}$ (mm^3/s) and $A_{wp,op}$ (mm^2/s) practical values based on operating time.

3. RESULTS OF THE EXPERIMENT

We calculated the machining times, the practical surface rate and the practical material removal rate for a bore hole. The parameters referring to five possible machining versions were investigated.

3.1. Machining times

Economic efficiency of machining can be evaluated on the basis of operating times too. Experimental results of machining time and operating time is introduced now.

Grinding has the longest machining time. The machining time of the gear wheel reduces to 21 percent (Figure 1) by hard turning (procedure version B), which has further reduction to 14 percent by using wiper inserts (procedure version C).

Also the operating times are always lower than in grinding. This is the result of the technological efficiency of hard turning but if loss times of dressing needed in grinding is calculated too, the result is totally clear [6]. The reachable times in combined procedure versions differ from the times of hard turning in a small extent. Performing of the two procedures in one machine tool, on one clamping facilitates the minimum grinding allowance. Therefore the machining time reduces to a minimum value, which means a large profit, especially by the long bore-hole grinding procedure.

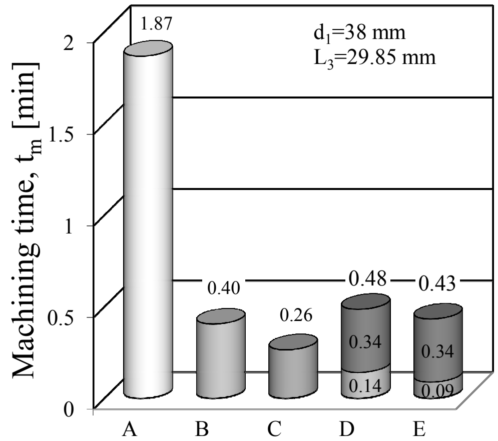


Fig. 1. Machining times in different procedures

Grinding has the longest operating time. Operating time of gear-wheel reduces to 24 percent (Figure 2) by hard turning (procedure version B), which has further reduction to 19 percent by using wiper inserts (procedure version C). The reachable times in combined procedure versions differ from the times of hard turning in a small extent.

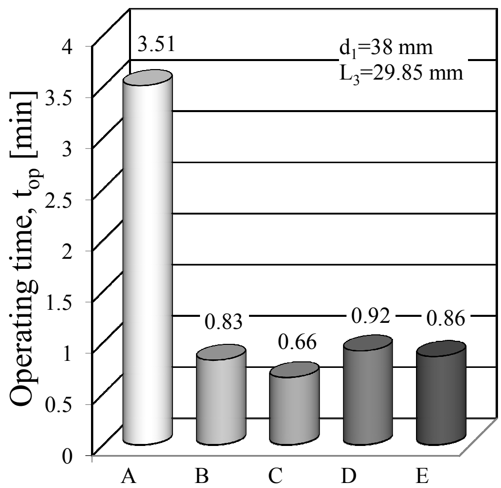


Fig. 2. Operating times in different procedures

We note that the costs can be calculated if the times are known. These values are not given here because they are influenced by the prices determined by the industrial and geographical position of companies and also by the applied cost counting methods.

3.2. Surface rate (SR) and material removal rate (MRR)

Surface rate by hard turning is more than four times as much as by grinding, and using wiper insert this value is more than five (Figure 3). Concerning the material removal rate, these values are similar (Figure 4).

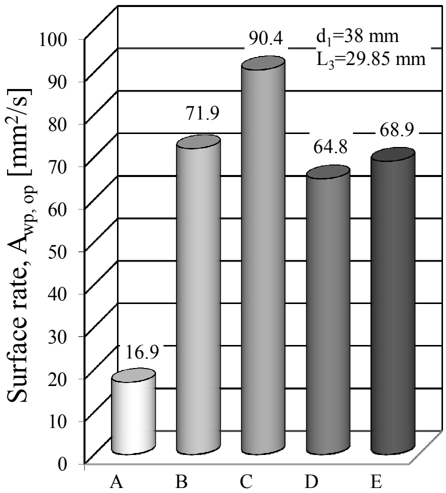


Fig. 3. Surface rate on the basis of operating time ($A_{wp,op}$)

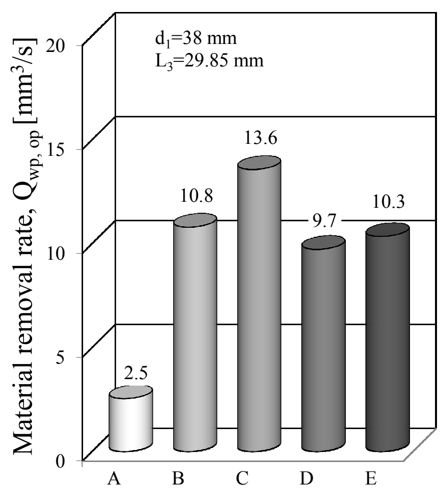


Fig. 4. Material removal rate on the basis of operating time ($Q_{wp,op}$)

4. CONCLUSION

The number of hard finished components built in engineering products is increasing. That is why the efficient and economic realization of quality properties providing functionality of the components is important.

The comparison of hard turning and grinding by machining bore-holes of gear-wheels showed the significant advantage of hard turning referring to economic efficiency. The existing differences were revealed by all investigated parameters, like machining time, operating time, practical values of surface rate and material removal rate. If the functional conditions of the components built in the product require ground topography, the application of the so called combined (hybrid) machining is suggested. This new solution provides economic efficiency in machining similar to hard turning

5. ACKNOWLEDGEMENT

The described work was carried out as part of the TÁMOP-4.2.1.B-10/2/KONV-2010-0001 project.

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The structure of mechanical clamps for handling cylindrical objects

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Abstract

The task of this paper is to structurally elaborate the mechanical gripper for handling cylindrical objects without human assistance or any other additional techniques. In the first part, the structural and functional features of the mechanical grippers are presented. A list of demands and wishes is also specified. The second part of the paper deals with the generation and evaluation of the principal solution. Using this mechanical gripper, cylindrical objects can be grasped and manipulated easily. Humanization of work was done and heavy physical work was avoided. It is applicable to closed facilities and for outdoor work. It is used for lifting concrete pipes, and for steel and plastic profiles.

Keywords: Theory of design; The structure; Mechanical gripper; Handling.

1. INTRODUCTION

The main goal of this paper is to elaborate the design of mechanical gripper for handling cylindrical objects. The design process represents one of the phases of integral product development [1]. The result of design process is design-technical documentation, which is the basis for every production. The main goal of the design process is to create the optimal product in the given circumstances in a short period of time and with low cost [2].

The unique design of the mechanical gripper enables a stable lift of the cylindrical objects, i.e. iron, concrete or plastic pipes. Furthermore, parts of sawn-up trunks, and cylindrical profiles of different diameter can also be lifted. This mechanical gripper would be used primarily when the working conditions are inhumane or when no other additional technique can be used. There are many such conditions in the industrial production, transportation and on building sites. Some of these sites include steel-plants where hot pipes (bars) must be lifted and transported from one work place to the other; or concrete pipes must be lifted during the building of the pipeline (Fig. 1).

These grippers are part of the system for handling and manipulation which enables temporary contact with the object which is being handled. They secure the position and orientation when carrying and handling the cargo. The power of gravity is used to allow the scissor action of the pipe tongs to clamp securely on pipe.

Fig. 1. Lifting of concrete pipes [3]

The need for transportation via conveyors and lifts exists ever since the ancient civilisations. Huge and heavy stone blocks, which were needed for the building of Egyptian pyramids, had to be transported and lifted with a help of special tools, i.e. some kind of ramps, because manpower was insufficient for this kind of work [4]. The system of pulley and lever was known in the Ancient Greece and the Middle Ages. Leonardo da Vinci (1451-1519) made the first rotary crane which consisted of a single arm supported on a circular platform. The model included hand cranks and pulleys and even a locking lever. The first mechanical power was provided by steam engines, and the earliest steam crane was introduced in the 19th century and was used especially in the mining industry. The first electric crane was built in Hamburg harbour in 1892. Modern cranes usually use electric motors and hydraulic systems to provide a much greater lifting capability than was previously possible, although manual cranes are still utilized where the provision of power would be uneconomic. Development and expansion of industry and production affects the modernisation and development of transportation devices.

2. NATURAL MECHANISMS FOR GRABBING OBJECTS – BIONICS

During evolution, many different mechanisms for grabbing have developed in nature. Fish mouth and bird's beak are some of the natural mechanisms for catching or grabbing. Insects display two types of adhesive feet surfaces: smooth pads (like in grasshoppers) and hairy surfaces (like in beetles). Geckos climb vertical and even inverted surfaces with ease using millions of micron-scale adhesive foot-hairs on each toe. Each foot-hair splits into hundreds of tips only 200 nanometres in diameter, permitting intimate contact with rough and smooth surfaces alike (Fig. 2).

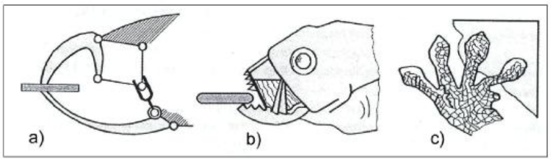

Fig. 2. Natural grabbing mechanisms: a) bird's beak; b) fish mouth; c) gecko's foot [5]

Elephant's trunk is also an example of universal gripper which can be used as an exploratory organ, for feeding, for drinking, etc. Almost all grippers are based on the same kinematic principle as the bird's beak or the elephant's trunk. For example, the system for paint spraying or workpiece clamping. Grippers for handling fragile objects are based on the principle of tentacles (of squids), and insect organs for catching and chewing are like tongs.

Problems of handling objects in complicated conditions were also solved during evolution. The ospreys have gripping pads on their feet to help them pluck fish from the water with their curved claws and carry them for great distances. At the moment of grabbing, the pads create vacuum on the soft surface of the object. In this case, several principles of grabbing objects were applied and therefore, a gripper with tongs was designed [6].

3. FUNCTIONAL CHARACTERISTICS OF MECHANICAL GRIPPER

The main purpose of designing mechanical gripper for handling cylindrical objects is [7]:

- stability and strength of structure when grabbing pipes of different dimensions and weight,
- safety in exploitation, safe and stable lift even when the pipe has been picked off-centre,
- adaptability to various types of loads,
- independent opening and closing of the gripper which is vital in some inhumane or inaccessible conditions,
- various types of use, exploitability and economy,
- adequate corrosion protection and protection from other harmful influences,
- the smaller the weight of gripper, the smaller the power of lift,
- use both indoors and outdoors.

4. DESIGN OF MECHANICAL GRIPPER

Mechanical gripper can clamp securely on cylindrical object in two places, while it is attached to the lift hook in one place. It is connected to the lift hook with a shackle (load capacity 100kN) as can be seen in Fig. 3. The support is made from HE-B 220 steel profile and it connects the lever arms with the lift hook (Fig.4).

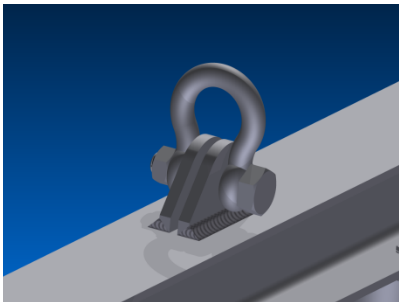

Fig. 3. Shackle connects gripper support to lift hook

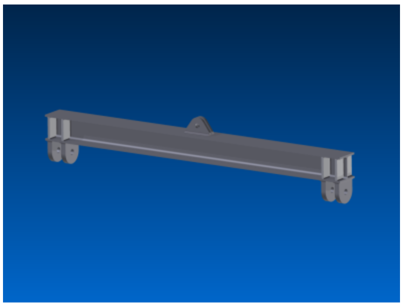

Fig. 4. Gripper support

The shackles at both ends of the steel profile and lever arms are secured with bolts (Fig. 5). Lever arms, i.e. tongs, are also connected with bolts (Fig. 6).

Bushings made of soft metal (Fig.7) are built–in between the bolt and the lever arms to avoid damages of bolts during operation of the mechanical gripper. Figure 8 shows a system for lubrication.

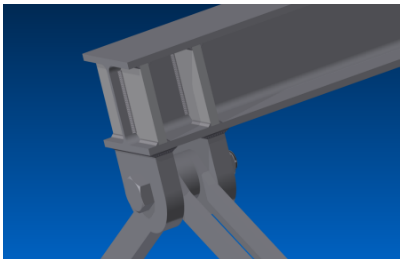

Fig. 5. Joint between beam and lever arms

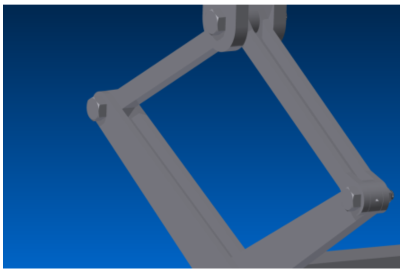

Fig. 6. Lever arm joint

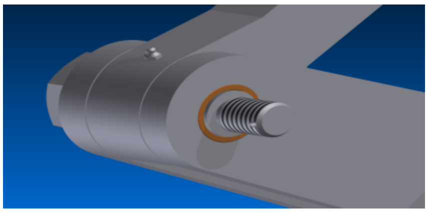

Fig. 7. Bushing between bolt and lever arm

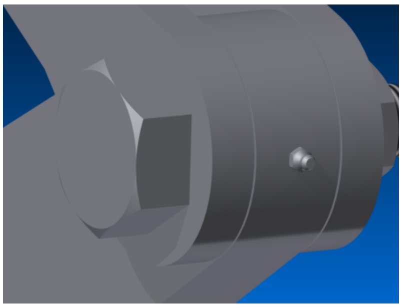

Fig. 8. Bushing between bolt and lever arm with lubricator

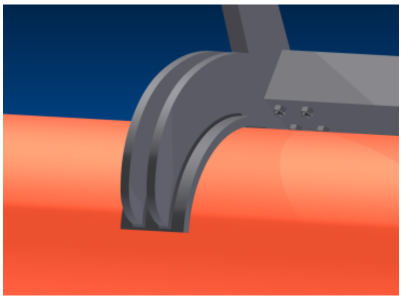

Fig. 9. Part of the lever arm used for handling cylindrical objects

Lever arms used for handling cylindrical objects are produced by welding (Fig. 9).

In order to make the process of handling objects automated, a special mechanism (Fig. 10) was created. It uses additional beam (Fig.11) to enable opening, i.e. closing, of the lever arms.

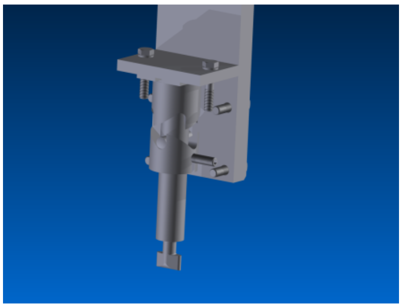

Fig. 10. Mechanism for automated opening/closing of lever arms

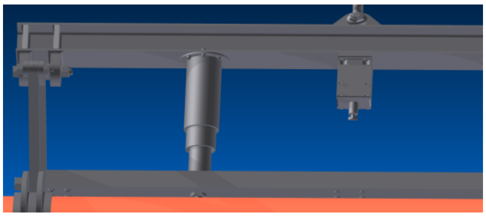

Fig. 11. Additional beam for opening/closing of lever arms

The mechanism for opening/closing the lever arms can function properly due to the fact that there is a telescopic guide for the additional beam (Fig. 12). Due to this mechanism, the operator can simply lower/lift the entire gripper in order to open/close the lever arms used for handling cylindrical objects. The mechanical gripper is shown in Fig. 12.

Fig. 12. Telescopic guide (for additional beam)

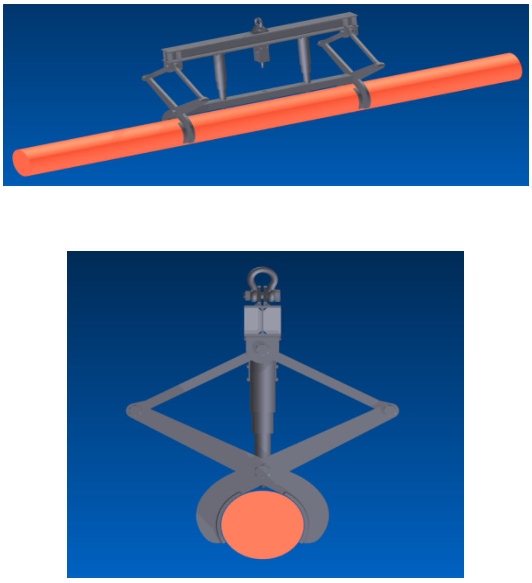

Fig. 13. Mechanical gripper for handling cylindrical objects

5. CONCLUSION

The design of mechanical gripper for handling cylindrical objects is presented in this paper. In order to provide simple and safe operation, all safety-technical factors had to be considered.

The use of computers and other tools can save time and minimise the possibility of making errors when developing some new product or when improving some existing product [8]. If the preparation is done properly, the results will also be adequate.

Even though the computer was of ulmost importance for this type of design task, some basic knowledge of design, i.e. calculation, is also necessary. Since the mechanical gripper for handling cylindrical objects is a structure which has to provide safe and simple manipulation, it was necessary to know which problems can occur in the real world.

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Change Management – the process of restructuring on example of "Croatia osiguranje"

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Abstract

The authors of this study discuss about area of change management and enterprise restructuring process , with special emphasis on case study from practices and a proposal of their own, the original model to restructure the company "Croatia osiguranje“ Inc. Zagreb. "Croatia osiguranje“ is the largest insurance company in Croatia and one of the leading insurance companies in the region. "Croatia osiguranje“ are in the crucial moment now. Domestic industry challenges, on the one hand, and Croatian European Integration Association process, on the other hand, require appropriate strategic reply to the companies that manages most insurance products.Well-modeled and well-implemented business strategy is the only way of achieving a sustainable business. A key part of the implementation strategy is to set up an organizational structure that will be able to achieve its strategic objectives. Suggested restructuring model which is used in this study stems from an analysis of the immediate and wider environment, as well as from the analysis of internal business systems capabilities.

The fundamental principle of this restructuring model is that the business system should be installed so as to increase accountability for the work done at all organizational levels. Two main components of restructuring that this study suggests is restructuring the macro - organizational structure and improvement of corporate governance.

In addition to defining strategic programs, goals and initiatives that will help the company "Croatia osiguranje" to realize a strategic vision in the forthcoming period, the purpose of this study was to improve strategic thinking in the ranks of top management companies. In this way, existing strategies will be able to adapt to changes in the environment more quickly and effectively, which willsignificantly affect the strategic context of the insurance sector in the Republic of Croatia. Restructuring process developed and proposed in this work contains two key elements, the economic justification and feasibility.

Analysis conclusions conducted in this study suggest that the intensity and dynamics of changes in the environment require immediate and urgent action at the “ Croatia osiguranje”. As a first step in enterprise restructuring process of "Croatia osiguranje", it is necessary to create a new Systematization of Work Positions and of the processes. This paper suggests four fundamental areas of restructuring in “Croatia osiguranje" Inc.: the Activity, The Directorate, the Corporate Governance and the associated companies. Special emphasis in this research is placed on the proposed new organization mode, separation of profit centers, and improving the system of remuneration.

Keywords: Project management; Restructuring; Transition; Business strategy; Sustainable business; Operating system.

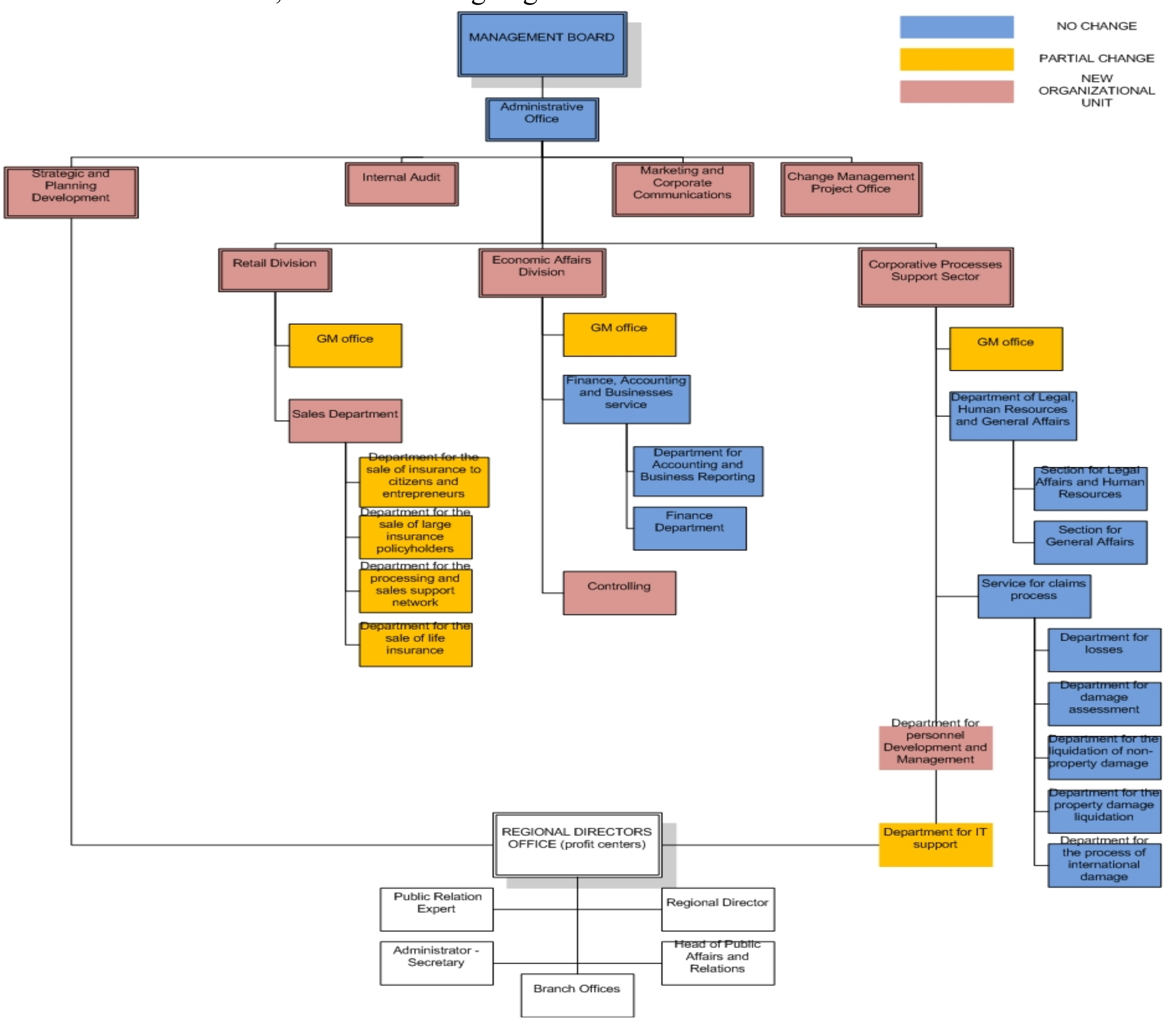
1. THE MODEL AND PROGRAM OF "CROATIA OSIGURANJE" Inc. RESTRUCTURING

The new organizational structure proposal of the "Croatia osiguranje” is based on the organizational changes and its task is increasing the efficiency of the company. For those organizational units that the existing organization have rounded up meaningful assignments and assigned duties that were carried out successfully proposed changes are not necessary. Every organizational change for employees is a source of uncertainty and seeks a certain time and resources for adaptation, so it is necessary to insist only on those organizational changes that have clear objectives and for which it's possible to review all the advantages and disadvantages and future advantages that the company can accomplish.

A detailed review of the tasks, which is the case of in the "Croatia osiguranje " Inc., where the Directorate gathers eighteen services of various sizes, can lead to tasks and responsibilities overlapping and is not conducive to more effective business operations. The number of services should be determined by the corresponding number and scope of operations to cover all tasks and activities that take place within the organization but in a way that respects the principle of service rationalizing, because each service produces costs to their respective department. Operations consolidation will facilitate the business processes development.

In addition, at certain circumstances, in the company "Croatia osiguranje", comes to the dual chain of command, where one is going directly from the head of department to department managers, and other indirectly through the subsidiaries to the regional director of the department. This kind of a situation is very disadvantageous for efficient performance of the functions and needs to be resolved before the company's restructuring. Taking into account organization entirety of the "Croatia osiguranje" and plans for the introduction of responsibility centers, there is a need that the regional director as a profit center manager has comprehensive power over the actions that occur in his subsidiary, and hence the departments.

The graph 1 shows the proposal of restructuring, a model of the new organizational structure of „Croatia osiguranje". The new organizational structure is based on some existing organizational units (services), some existing organizational units for which was proposed change of the activities and some totally new services.



Graph 1. "Croatia osiguranje" restructuring model

It can be stated that the restructuring model provides couple major innovations as compared to previous solutions. Firstly, it is proposed services consolidation, thus eliminating redundant processes and opening a new service that will enable increased efficiency, which is the goal of restructuring. Furthermore, services are divided in three sectors according to their core business segments: for Operations Management Sector, the Economic Affairs Sector and the Corporate Support Processes Sector. The division of services close to the sectors that are responsible for certain management member's aims to improve communication among services and to more clearly define basic business processes groups that take place in the company.

Further, it is necessary to establish four organizational headquarters units that are directly associated to the CEO, namely: the Strategic Development and Planning Office, Corporate Communications and Marketing Department, Internal Audit Department and, crucial, service for the restructuring model implementation that is called the Change Management Project Office.

2. CONCLUSIONS

The restructuring is a process that is essential in daily business operations because it directly influences the increase of profitability, cost efficiency, also increases the market value of the company and considerably impact the efficiency of the Corporate Strategy implementation. Also, it does not matter whether the company is in public or private ownership, because the restructuring does not know the particular category of businesses property; in particular if one looks at that success of the restructuring process within any organization depends upon the organizations capacity to manage change and the communication effectiveness. It is also required to clearly demonstrate why are major changes in the process of restructuring, and it is necessary to include representatives of employees and /or unions, to agree the objectives and vision for the restructuring and quickly and transparently show the results of the restructuring implementation.

Analysis Conclusions conducted in this study suggest that the intensity and dynamics of changes in surroundings require an immediate and prompt action at the "Croatia osiguranje" Inc. As a first step in enterprise restructuring process of "Croatia osiguranje", it is necessary to create a new Systematization of Work Positions and of the processes. This paper suggests four fundamental areas of restructuring in “Croatia osiguranje" Inc.: the Activity, The Directorate, the Corporate Governance and the associated companies.

Also, it is concluded that the restructuring process implementation raises major challenges for the company and all involved interest groups. Under the pressure from globalization and of permanent new challenges in environment restructuring, it became the constant and essential activity of the company. Croatian companies are lagging behind the West European companies in the restructuring and still most of the Croatian companies dedicate small amount of time to this important task, which leads to the question of the effectiveness of the restructuring implementation within the businesses.

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3-day Sailing Activity for Non-professionals (amateurs)

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Abstract

Sailing is a most exhilarating sport and recreational leisure activity but insufficient education puts it into position as a sport for professionals only. This research wants to prove the hypothesis that in period of 3 days non-professionals can learn basics of Sailing, life habits and behaviour on the boat for recreational activity. Spending minimum of 3 days on the sea and on the boat will show how many benefits for participants health this activity will have – aerobic fitness, cardio-vascular fitness, anaerobic capacity, muscular strength, flexibility, agility, water, sea air, climate, sport in general. Putting an individual in a specific situation where informing, educating and rising awerness of Sailing aims for healthier life of each individual. An Experiment is used as the main method for the research – a skipper chose 4 participants to spend 3 days on the boat to have an active education and training of Sailing. The approach to the topic is that 3 days are enough to prepare non-professionals for Sailing and to widen their horizons about Sailing. The 3 day period is long enough to educate and rise awareness of an individual about the benefits that Sailing can have on health which has huge importance in changing life habits of the participant.

Keywords: Sailing; Education; Recreational Activity; Health Benefits; Life Habits.

1. INTRODUCTION

Sailing is a most exhilarating sport and recreational leisure activity but insufficient education puts it into position as a sport for professionals only. This research has a goal to prove the hypothesis that in period of 3 days non-professionals can learn basics of Sailing, life habits and behaviour on the boat for recreational activity.

Spending minimum of 3 days on the sea and on the boat will show how many benefits for participants health this activity will have – aerobic fitness, cardio-vascular fitness, anaerobic capacity, muscular strength, flexibility, agility, water, sea air, climate, sport in general. Putting an individual in a specific situation where informing, educating and rising awareness of Sailing, aims for healthier life of each individual.

A Skipper and 4 non-professionals went on a sailing boat for 3-day Sailing as a recreational activity along the Adriatic Coast and the Skipper had a task of teaching them to sail and to live the life on the boat.

2. 3-DAY SAILING ROUTE

2.1. First day Sailing

After the crew has come on the boat the Skipper introduced them with the parts of it.

He gave them logbooks which they will be writing at the end of each day.

At first the crew has to meet with the basic information about the security on the boat – security belts, floating rafts. The Skipper informes them about the obligation each member of the crew has while setting sails.

On the helmsmans sign one member of the crew has to untide mooring and throw it in the sea, has to watch out the release of the leeward rope, and then the release of the windward rope.

After setting sails the crew has to put away the fenders and to put the ropes together. The

Skipper explains them how to get in their positions and how to change those positions (helmsman, mainsail trimer, genova timer, pitman and bowman). For start, changes of the positions are only at the helm since the crew has to get the feeling of the helm. The rest of the crew are being taught about the basics of nautical maps and the navigation.

In a short sailing route along the Adriatic Coast the crew is sailing towards the cove to practice anchoring which demands of a person to be cautious and to have marine skills because of its depth and the frequent wind blowing direction changes.

While sailing, the crew is learning about the different types of knots. The crew is sailing back to the marina to finish their first day of sailing.

After sailing in in the marina each memeber of the crew has to write their logbooks. The Skipper has a task to educate them about the parts of the boat, apparent wind and to describe the full circle – close hold sailing, crosswind sailing, half turn sailing and down wind sailing.

The first day of Sailing was very educational and without it it would be impossible for the crew to sail especially if they would have experienced any difficulties where their life and health could have been in danger.

2.2. Second day Sailing

For the crew the second day has started with the setting sails and raising the sails in the way that the boat turns towards the wind.

First they have to raise the main sail and afterwards to raise genova. Second task for the crew is to practice the acceptance and downtrend in a way when accepting the sail they have to watch the front hem of genova and accept it all the way until it starts to shake and then they have to tight it up a bit. While practicing downtrend it is necessary to fall it until the sails start to shake and then to tight it up.

Later on, the team sails to the deep and tight cove to practice anchoring.

After a short break the crew has started to navigate towards the port to practice anchoring to the pier. The Skipper teaches his team how to anchor to the pier and explains the importance of letting off five times more meters of chains than it is the depth of water and shows them how to tie it at the end with the stern ropes.

The crew has successfully parked the boat and went to the restaurant to have a lunch and a short break.

The next task is to practice anchoring in the cove and afterwards to sail back to the port. Since the crew has once more succesfully parked the boat the Skipper has a task to educate them about the aerodynamics, hydrodynamics and to theoretically describe the tacking and gydeing. Since the day 2 has come to an end they have started to write the logbooks and went for a dinner afterwards.

The second day of Sailing was very active and it demanded a muscular strength from each memeber of the crew but besides that it was a good practice for the third day which is planned to be more active than first two days.

2.3. Third day Sailing

The morning starts with the breakfast and afterwards with the setting sails and raising the sails, as usual. This day is scheduled for practicing tacking and gybing.

Tacking is the act of changing the direction of the sailboat by bringing the bow into the wind. [1] It is a turn in the wind for 90 degrees. Tacking has be done from the maximum acceptance when the wind starts to blow from leeward side of sail. Helmsman turns the boat for 90 degrees in the wind, and the genova trimer takes over the genova on the other side. After few tacks the crew sails further more to practice gybing.

Gybing is the act of altering the course of the sailboat by bringing its stern through the eye of the wind.[1] It is necessary to be catious because the mainsail will, if you don't control it, while going on the other side, tear down everything around and it can be dangerous for the crew.

After 3 days of constant living on the boat the crew has successfully finished their recreational activity and learned how to sail what we wanted to prove by this research.

3. HEALTH BENEFITS OF SAILING

In the period of 3 days on the boat 4 non-professionals have experienced various benefits for their health in general.

Sailing is a sport where an individual has to use the full muscle strength because of very active moves of the body that are necessary for the whole round of Sailing – from setting sails, through tighteing and tideing the ropes, tacking, gybing, anchoring, etc which coresponds with aerobic and cardio-vascular fitness. Muscle strength increases the body's metabolic rate by helping your body burn more calories. Muscle endurance is very important during repetitive moves and it can be accomplised by moderate resistance training and a moderate amount of repetitions.

The health benefits of sailing affect aerobic capacity. Aerobic Fitness is associated with a reduced risk of obesity, hypertension, and ischemic heart disease. Anaerobic capacity on the other hand is affected by movements such as tacking and gybing, which increase anaerobic capacity.

Flexibility and agility are also part of the health benefits of sailing. How your body moves and how fast you can move comprise flexibility and agility which is of huge importance in tacking and gybing. [2]

Studies show that sea air is charged with healthy ions that accelerate the body's ability to absorb oxygen. It also helps balance the levels of serotonin, a chemical produced by the body that is associated with mood and stress.

While living on the boat an individual goes through some difficulties that are not often in living in the house or an apartment. That is especially important to consider while thinking of possible injuires and prevention of them. [3]

On the land there are enough room to do certain action but on the boat wanted action is done in much smaller space.

As already said, sailing is an active sport, but if non-professionals sail without educating first, there are so many possible damages and dangers that can be caused by it, such as: breaking parts of the body, crashing the boat which can cause the injuries of head, loss of balance, drowning, inner injuries or just slight straches.

The other aspect of having health difficulties is experiencing sea sickness. To heal it, it is necessary to educate ourselves about symptoms to know what to do in case we have them.

There are lots of pharamaceutical products that can help healing but it also helps to adjust the nutrition, to avoid the intensive smells such as parfumes, to sit in the direction of sailing, to avoid any eye efforts,... [4]

While Sailing, we are directly exposed to the sun so it is of huge importance to have a high UVA and UVB protection – both for skin and for eyes. UVA and B rays damage vitamin A in the skin, UVB rays make burns on the skin and UVA rays indirectly damage DNA cells. [5]

4. LIFE HABITS ON THE BOAT

It is always good to have people hanging out, spending their time on the sea, planing and doing something together that they have never experienced before with enthusiasm and excitement but it is also important not to exaggerate in enthusiasm because many people get dissapointed after spending few days together on the boat.

To avoid dissapointments and arguing between people it is neccessary to think about some circumstances of living together on such a small place as a boat and on such a wide place as a sea.

Spontaneous roles lead to difficulties and that is why they have to be replaced with rules.

Order, firm schedule and obeying the rules are prerequisite of living together in a small space. Rules and life habits from the land are not usable on the boat, make confusion and produce unneccessary anger and loss of enjoyment.

Considering all those facts, no matter how it seems to be formal, it is important to define rules of behaviour, small chours and obligations, so that the time spent on the boat can be fun and relaxing.

Crucial role on the boat has a leader of the boat – a Skipper. His obligations are to take care of security on the boat, to give precise chours to the rest of the crew and what is most important to remind them of their goals and plans that keep them together on the boat.

The first crisis on the boat is a time when authority of Skipper has a crucial role and if the organization on the boat is bad it will affect everyone.

It is as important to have maritime knowledge, as the ability of the organization, determination and taking responsibility, breaking the schemes of conducts within the mainland.

Small boat is a big school of life, where in the small space we meet with circumstances that are usually spread along in the wide space in everyday life.

The excitement and desire to enjoy in the sea, sky, wind, that join together and meet in sailing on the small boat and fellowship of the crew may end up well just when incorporated with a sense of mutual obligation in which it can be much more important taking out the trash and maintaining order in the ship's saloon, then sophisticated naval knowledge to what summer sailors often refer.ć

Small and closed space, according to human nature, leads to increased hypersensitivity which does not show up in situations when we have somewhere to move. These situations give every individual a chance to meet himself and to discover if we are honest with ourselves. [6]

One of the principles is not to wait on others to do some job, but to do it yourself and to inform the others about the job done. In this simple way of creating a positive atmosphere even the laziest one among the crew, who usually most of the time waits on the others to complete their job, is encouraged to do the chours.

Living on the boat is an opportunity to unmask the grubby and selfish people.

On the other side, it would be naive to expect that spending few days together can change people but it certainly can spread their horizons.

5. CONCLUSION

Sailing offers you fresh air and relaxation as well as overall fitness. Sailing benefits your heart, your breathing, your muscle strength and endurance. Sailing is beneficial both physically and mentally and nothing can do better than that. The health benefits of sailing will provide you with overall well-being.

Because of sea air it is conclusive that spending a holiday out on the sea, sailing, or cruising can make people feel more relaxed and energised.

It is of huge importance to educate ourselves and to go into something new educated and informed first, otherwise many obstacles, difficulties, injuries and damages are possible.

As we have assumed, we used an experiment as a method to prove that 3 days were enough to educate 4 non-professionals about Sailing and life on the boat and we have proved it. The team on the boat has improved their knowledge in Sailing and has spread their horizons about the tolerance and relationships between people. Sea and the boat in combination with the people are a great source of excitement which always leads to planning another activity on the boat but it is necessary to respect people, the boat and the sea.

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Flexibility exercises usage during lessons within Educational Kinesiology

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Abstract

The word ″flexibility″ comes from Latin *flectere* or *flexibilis* which means *to bend*, *bending*. According to Milanović [1], it is the ability to perform a motion by a large range of motion, and the most common measure of flexibility is a maximum range of motion of body parts in individual joint systems. Kinesiology operators, depending on intensity and duration, are a way of influencing on the muscle tone levels and improving the ability of the locomotor system in performing the maximum range of motion in one joint or series of joints, and nervous-muscular regulation of organism. Tasks of the part of the lesson in function of flexibility improvements are: determine which topological body regions we want to develop, establish the selection of exercises and stretching methods, and determine number of series, time intervals and breaks. All those tasks are conducted in accordance with objectives of the lesson. It can be a lifelong improving experience in different materials and space conditions and has a very wide range of application in real life, as well as in higher education institutions. At the University of Applied sciences of Slavonski Brod it is applied in every physical teaching activity, in the introductory, preparatory, primary and final part of the lesson. Improvement of flexibility is a significant characteristic in health focused way of life and should represent an important aim in physical exercising and education. The reason for writing this paper is that, due to the lack of habit and knowledge on proper performing of stretching technique, the risk of injury increases and optimal transformation and student development during exercising decreases. It is extremely important to educate, direct and motivate students to perform the flexibility exercises correctly for the purposes of achieving maximum functionality during exercising and health prevention.

Keywords: Education; Flexibility; Exercise; Influence; Prevention.

1. INTRODUCTION

Only a systematically prepared physical education lesson can be adequately conducted and have educational and transformational effects. The knowledge and methods of performing flexibility exercises is one of the initial steps in physical exercise which the student population should know how to conduct. Determining the appropriate flexibility exercises in the curriculum, prepares the students for movement and enables the body an easier path from inactivity to complete intensive physical activity. Flexibility and functionality of all regions are the ones that cause the majority of primary body movements and they are responsible for the stability of the body. In real life, it is very hard for students to self – motivate and practise stretching exercises in a continuity in order to maintain and improve their flexibility. The majority of the students possess a certain lack of basic knowledge about proper stretching. All the movements, in which muscles stretch over their normal physiological length which they usually have in a state of inaction, constitute stretching. Any movement that brings body parts to a point of increasing in joint motion can be called a stretching exercise [2]. Then there is the belief that if stretching doesn't hurt, there is no actual improvement. Another understanding is that teachers themselves don't present stretching exercises as something educational, influential, practical and useful in daily life. The cause of decreasing or loosing flexibility in contemporary world can be assigned to a kind of inactive lifestyle among other things, the lack of activity and any kind of physical activity which has a negative effect on the anthropological status and the muscles tend to shorten their length. Various authors have a different definition of flexibility. Most of them define it as a range of motions in one or more joints [3]. In regular muscle stretching, the range of motions is increased and that makes us stronger, more capable and more agile in the lesson, when playing, at work and in daily life. Other positive effects that stretching has on the human organism are: improvement of self-awareness and body control, prevention of locomotor system injuries; pain, fatigue and muscle tension reduction, improvement of blood circulation and other regenerative processes and advancement of muscle and inter-muscle coordination [2]. The aim of this paper is to make students aware of the need and influence of a simple approach to maintenance and development flexibility exercises in daily life. This simple approach to exercising and a little time invested every day can help in prevention of health of the locomotor apparatus. It would be desirable for people who spend a lot of time in front of the computers every day, students between long classes and general population to apply these exercises regularly. Stretching is not a physical activity reserved only for those who do sports, but it is an essential part of daily life with the purpose of renewing agility, health prevention, influence on a more active life style, stress reduction, muscle relaxation and finally, it benefits a better general organism shape. It is therefore necessary to educate students about the meaning and effect of flexibility in order for them to use their free time more effectively and thus satisfy their individual needs, increase their working abilities and preventively influence their health.

2. BASIC RULES AND STRETCHING PRINCIPLES

At the University of Applied sciences of Slavonski Brod, physical education lessons are conducted during the first four semesters and it is mandatory. Locations on which the lessons are conducted often vary, depending on the conditions under which they can be realized (sports gym, bowling alley, fitness studio). Regardless of its location, the lesson always includes stretching exercises as part of the kinesiology education, maintaining and development of flexibility in the student population. Flexibility exercises are mostly conducted in the initial and the final part of the lesson, although they can be applied in all parts of the lesson, depending on the aim and the possibilities. During every lesson that is under the influence of certain kinetic contents, transformational processes in which students are focused on developing the mobility of particular body parts or of the whole body, take on an important role in the lesson. Models of using flexibility contents are formed for preparation of the joint – muscular system, with the goal of realizing a quality performance in the main part of the lesson and using those contents for relaxation of the body in the final part of the lesson. One of the most important rules to follow is to know that before exercising, the student's body is in a state of homeostasis (homeostasis is defined as keeping the organism stable and calm) and for the body to achieve a new physical state, it has to expose itself to "stress", so the state of inaction is transformed into a process of adaptation which causes extension and strengthening of the muscles. Regardless of the stretching method, it is important to know what is the structure and the function of the muscle which is being stretched (the teacher educates the students and explains the effects of certain exercises on particular muscles). Regarding all these facts, we can see a principle which should be taken into consideration when growth or development of mobility is regarded. Safety during exercising represents the most important aspect which the teacher ensures: recognizing and eliminating danger if possible, controlling the dangers that can't be eliminated and not creating any additional dangers. It would be ideal if all the students could undergo medical exams which would guide teachers to determining which types of stretching exercises might be contraindicated for students. It is necessary to determine the goals before entering the exercising program. Every set of exercises should be made so that they correspond to students' specificities and homogenised groups. It takes time to develop mobility, so it is necessary to set realistic goals and apply easier exercises first and then continue towards harder ones. A well planned program should be written down and monitored in order to change types of exercises as the students progress (intensity, duration and frequency). A positive psychological state is a postulate so better results could be achieved in the physical state. It is essential to breathe properly and to be totally concentrated on the muscle group that is being stretched. Students should be familiar with the stretching technique in order to correctly identify and isolate the muscle group that is being stretched, for the achievement of maximum results. In general, stretching exercises should be conducted slowly without sudden movements which could cause pain and injuries.

3. FLEXIBILITY IN THE INITIAL PART OF THE LESSON

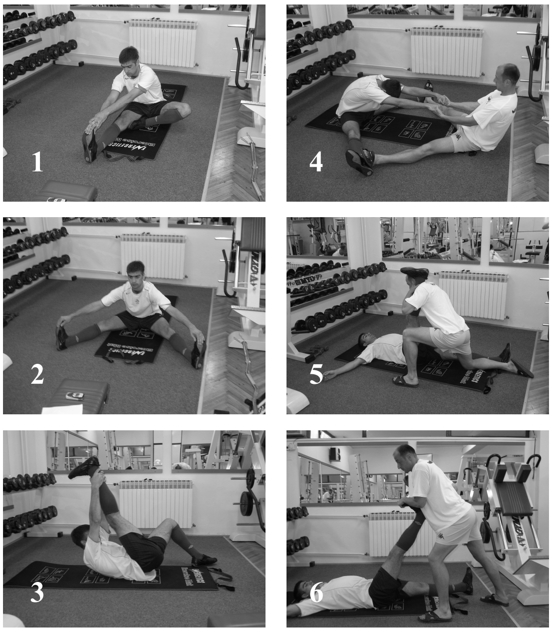
A complex of general preliminary exercises is used in the initial part of the lesson. They are actually dynamic flexibility exercises – the ability of performing dynamic movements through a complete range of motions in a certain joint [3]. Dynamic flexibility exercises are used in this part of the lesson because every muscle should be stretched to its utmost nominal limit. It is also necessary to adapt the locomotor apparatus to different types of muscle strains, i.e. muscle contractions that await students in the main part of the lesson. The basic characteristics and goals of these exercises are: relaxation exercises and loosening the muscles, muscle stretching exercises and muscle strengthening exercises [4]. This way, muscles have an adequate strength and tone needed for the continuation of the training lesson. It is necessary to reduce energy consumption for one exercise unit, i.e. increase the level of the effectiveness of particular organic systems [5]. Exercises have a wide range of application in classes, in all conditions and locations (a gym, a bowling alley, outdoors, fitness studio). In this part of the lesson, the students are sorted in a free formation. The exercises are conducted in a standing, lying, kneeling and squatting position. Combinations of jumps, hops, swings, turns, thrusts, bends, lifts, circling and other movements are used [4]. Students perform a minimal of 8 exercises (standing and moving), 14 repetitions of dynamic stretching. Motions are relatively slow. Inertia is used without special conscious contractions of any muscle group [6].

4. FLEXIBILITY IN THE FINAL PART OF THE LESSON

Exercises of active/passive static flexibility can be used in the final part of the lesson – the ability of achieving and maintaining an outstretched position in a particular joint (more of them), using only the working of agonist and synergist / using own body weight, own extremities or certain exercise instruments [3] (e.g. stretching in pairs, stretching up against the wall, with the help of Swedish ladder, benches; chairs and natural obstacles can be used in daily life). A significant reduction of activity intensity is characteristic for this part of the lesson and training burdening is reduced so the organism would be in a suitable condition for a quality recovery. Students are sorted in a free formation. Exercises are conducted without sudden movements, stretching should be conducted only to a point when a feeling of ease appears, not pain. With static stretching, students are in one position at a maximum of 15 – 20 seconds (10 second breaks between exercises) and they should repeat it twice. An example of static active stretching exercises for the final part of the lesson (main part of the lesson – development of repetitive strength, fitness).

1) Squatting position, stretching the arms up above the head. Cross the fingers, palms upwards, stretch the torso and arms. Hold in this position.
2) Squatting position, stretching the arms up above your head. Swing to the left, then to the right. Hold each position 20 seconds.
3) Support on the arms. Palms and feet are on the ground. Bend the body, looking up. Hold this position.
4) Support on the knees. Round the back into a hump. Hold this position.
5) Squatting support, stretching the arms up above the head. The head and arms relaxed. Hold this position.
6) Feet apart sitting, deep forward bend. Hold this position.

Image 1., 2., 3. Example of static active flexibility exercises and **Image 4., 5., 6.** Example of static passive flexibility exercises.



5. CONCLUSIONS

Flexibility exercises in class can serve as a quality preparation of the joint – muscular system, stretching and muscle relaxation, which ensures the quality of performance and enhances psychic relaxation, but it also ensures the prevention from possible injuries of the locomotor apparatus. Flexibility training is used in this context, most frequently in the initial and the final part of the lesson. Nevertheless, this amount of activity can't be regarded as development training neither by its' range or frequency, but only by its' preparatory or relaxation content [7]. Much more time would be needed to isolate the development effects in flexibility – more lessons, which is usually not the case in the curriculum. Exercises alone are not stressful; they are controlled, relaxing and not competitive. Anyone can practise them with the right approach. So students should be motivated and educated to practise these flexibility exercises in their free time and accept it as an aim and the need of a contemporary civilization.

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Structural analysis of tactical means in final attacking in football

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Abstract

Structural analysis implies knowledge of typical situations in the game on which the coaches choose the appropriate content of the training. Decision-making system in the game (Gabrijelić, 1977) must be based on the concept of the game. Knowing the structure of the game (Trninić, 1995) means an understanding of all phases and sub phases of the game course and the position of certain players, which helps us to recognize certain situations in the game. From the standpoint of structural analysis, there are three areas of the game: attacking phases, defending phase and transition. Each of these stages has its sub phases. Each phase of the course of play has specific characteristics with defined goals within a tactical action. Coaches require the player's rapid transformation from defense to offense and vice versa. The parameters that shape the action in the game are (Baric 2007): rules (1), technique (2), motor communication (3), motor strategy (4). In the attacking phase the most important sub phase of the game is final attacking with the appropriate tactical means. The main objective is to structurally analyze the offensive tactical means, with special emphasis on those used in the final attacking. Partial objective is that this work serves as a professional paper in further education of football coaches.

Keywords: Football; Tactics; Structural analysis; Phase of the attack; Tactical means.

1. INTRODUCTION

It is used to determine the typical structures of the motions, substructures and structural units of the sporting activity. Understanding of all phases, sub phases and the typical situations of the game course means understanding the structure of the game. Decision-making system in the game must be based on the concept of the game[1]. Knowing the structure of the game means an understanding of all phases and sub phases of the game course and the position of certain players, which helps us to recognize certain situations in the game[2]. From the standpoint of structural analysis, there are three areas of the game: attacking phases, defending phase and transition[3]. Each of these stages has its sub phases. Each phase of the course of play has specific characteristics with defined goals within a tactical action. Coaches require the player's rapid transformation from defense to offense and vice versa. The parameters that shape the action in the game are: rules, technique, motor communication, motor strategy[4]

2. TACTICAL MEANS IN FINAL ATTACKING IN FOOTBALL

Tactical means in football can be group and individual tactical means. *Group attacking tactical means are*: passing the ball, receiving the ball, change of positions[5]. *Passing the ball* is one of the most important means of tactics in the attack. The selection of appropriate techniques of passing causes the position of a team-mate to whom the ball is directed, depending on his movement and position of opposition defense-players. We distinguish the following types of passing the ball in relation to the direction of passed ball: passing the ball to meet a player who is moving towards it, diagonal and vertical passing in front of team-mates, into the free space, parallel passing to a team-mate in the width of the pitch, passing back in different directions. Types of passing the ball with regard to the distance: short passes (up to 10 m), medium passes (10 to 30 m), long passes (over 30 m). The ball to a team-mate can be passed over the ground or by air, in terms of tactics it is necessary: to pass the ball in a timely manner, to pass the ball to a team-mate in the best position, pass the ball from the opposite direction from which it came, time the passing in order for a team-mate to master the ball easily. *Receiving the ball* is the second member of the pair in group attacking tactical means to ensure the ball possession and communication between team-mates. Modern football determines that the players receive the ball in motion. A prerequisite for such a takeover of the ball is the perfect individual technique of all the players in the team.There are following ways of receiving the ball: receiving the ball on the principle of depreciation, receiving the ball after bouncing from the surface, transfers of the ball. *Change of the position* of the player in attacking action is conditioned by the opponent's defense-players who strictly cover the attack players. Change of the position is a group tactical means of attack that is performed in order to violate the placement of rival defense players and to create free space for an offensive action. Changing positions is closely related to the disclosure.To be effective, the change of position in the offensive actions must be: timely coordinated, related to the coordinated development of specific actions, performed by running in behind a team-mate, in front of team-mates and in front of opponent players. *Individual offensive tactical means are*: shots on target, dribbling, dribbling and feinting, the detection of players[5]. *Shots on target* are usually the result of a group game. For the successful performance of shots on target, a player must have an appropriate technique. Power of hitting in football is conversely proportional to the precision. For efficient execution of shots on target it is necessary: to select the appropriate technique of hitting depending on impact velocity, direction and path of the ball, to choose the optimal direction and speed with the ball, and the moment of impact performance, the timely and proper posting in relation to ball passed by a team-mate, to select the optimal length of the counter-swing and swing of an impact leg, in situations where the offensive player is distracted, it is effective to apply the tricks before shots. *Dribbling* is the individual agent of tactics that serves the interests of team games. It enables: the realization of individual actions towards the opponent's target; team-mates in attacking provide support by spotting, changing positions and running into free space and creation of a favorable situation in the attack; dribbling is the most commonly applied in sub phases of preparation and in the mid-attacking. Generally, keeping the ball slows down the game and thus reduces its dynamics. In modern football dribbling has its value if applied with purpose by players in typical situations. *Tricks with the ball (dribbling and feinting)* in the game are used by players to create a spatial advantage over the opponent. By dribbling an offensive player deceives the opponent's defensive player with an abrupt change of movement of the ball, and by feinting he disrupts the balance with false movement of the body, in which case the ball keeps the direction of movement[3]. From a tactical point of view we divide dribbling into: imposed dribbling, positional dribbling, offensive dribbling. Bluffs can be used regardless of the position of opponent defensive players. *Disclosure of players* is the main way of cooperation of two or more players. Technical and tactical proper and timely disclosure reduces the opportunity of the defensive players of the opposing team for direct and indirect coverage. Disclosure can be: real disclosure, misleading disclosure, supporting disclosure, covering disclosure. Disclosure must be timely; team-mates have to approach in and out the space. At the same time more players have to perform disclosure which must be done systematically and purposefully. Disclosure must be done by fast separation from the opponent defensive player.

3. CONCLUSION

Football is undoubtedly one of the most dynamic and popular sports, the most important secondary thing in the world. There is almost no place where football is not played. With its progress, various technical and tactical requirements, football puts coaches and players in new temptations with very high standards. Coaches must go through permanent trainings in order to apply their knowledge in the training process taking into account the individual anatomical-physiological and psychological characteristics of players. From the very beginning of the game the basic requirement has always been the same, to score more than the opponent. At the beginning the game systems were based on enhanced defense, however, they have changed over time and have been adapting to the game with multiple attackers. Through the characteristics of a modern way of the football game it is evident that the team is divided in three lines (defensive, midfield, attacking). Also, structural analysis of a football game shows us that today's game is dominated by elastic systems characterized by shallow distribution of players. From the standpoint of structural analysis there are three areas of the game: the phase of offense, the phase of defense and transition, i.e. the transition from the phase of defense into the phase of offense, and vice versa. Phase of attacking can begin from all three areas or zones associated with vertical spaces. In the attacking phase we distinguish three characteristic zones of attacks in a vertical space of the pitch: zone of preparation or opening of the attacking, zone of central attacking and zone of final attacking. Through the analysis of the football game it is seen that the closing of the attacking can be performed through group and individual offensive tactical means, by cooperation of two or more players through the central or wing position. Today, more efficient realization is done through the creation of surplus players in wing position due to excessive concentration of players in the midfield.

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Cyberbullying, attitudes towards reading and academic success of primary school pupils

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Abstract

The aim of this research was to explore a possible correlation between doing and experiencing cyberbullying, variables of reading and using internet and academic success. Seventh and eight-graders of primary schools from Zagreb and Zagreb County (N=263, 44,1% M, 55,9% F) were given a questionnaire that consisted of Attitudes towards reading scale, Cyberbullying scale and questions about their internet usage and reading habits.

There is a significant positive correlation between academic success, how much pupils like to read and their estimation of the quality of their reading. Variables of reading are positively intercorrelated and so are the variables of doing and experiencing cyberbullying, which are also related to how often they play computer games. Pupils who have more positive attitudes towards reading have better grades and are less likely to be cyberbullies.

Boys are more likely to be cyberbullies and victims of cyberbullying and girls have better grades, like to read more and have more positive attitudes towards reading.

Pupils who spend between one and three hours per day on internet like to read more, have better grades and more positive attitudes towards reading than pupils who use internet more or less time per day. The more they use internet daily, the more they play computer games and are more likely to be cyberbullies and victims of cyberbullying. Pupils who communicate via internet only with persons they know personally have more positive attitudes towards reading and are less likely to be cyerbullies and victims of cyberbullying than those who communicate with persons they don't know personally. Pupils who went to meet someone they knew only through internet have more negative attitudes towards reading, are more likely to do or experience cyberbulling and like to read less than those who didn't go to meet their "virtual friends".

Keywords: Cyberbullying; Attitudes towards reading; Internet; Academic success.

1. INTRODUCTION

Cyberbullying, defined as using modern communication technologies to support deliberate, repeated, and hostile behaviour by an individual or group with the intent to harm others, is generally considered to be a relatively new, indirect form of bullying. Cyberbully does not harass others in a face-to-face interaction, but instead through an interface (computer screen or mobile phone). According to previous research[6], around one quarter of primary and secondary school pupils are victims of bullying, and cyberbullying occurs at the same rate[2]. UNICEF research in 2010 showed that 34% of Croatian pupils are exposed to cyberbullying[12].

Research also shows similar, if not the same, negative effects on the victims; Children who are bullied often develop internalised problems such as anxiety, loneliness, low self-esteem, overcompliance, and general insecurity[7][8][9] and may display externalising problems such as impulsiveness and hyperactivity[3] or avoid school[11]. Victims of cyberbullying display similar negative effects[10], which include poor concentration and lower school success as well [1].

Our previous research on Croatian primary school pupils showed that victims of cyberbullying have significantly lower self-perception of their physical appearance and behavioural conduct[4]. We have also found that pupils with better reading habits and more positive attitudes towards reading have better self-perception and better school grades[5], and every-day practice shows that those who read more have better general knowledge, therefore might learn better of the unacceptability of violence, including cyber violence. Beacus eof those assumptions, it was interesting to examine is there a relationship between reading habits, academic success and cyberbullying.

2. METHODS AND MATERIALS USED FOR RESEARCH

Seventh and eight-graders from four primary schools from Zagreb and Zagreb County (N=263; 44,1% M; 55,9% F) were given a questionnaire that consisted of *Cyberbullying scale* (constructed for this research; consisting of 20 items describing elements of cyberbullying on which participants estimated, on Likert scale of 5 degrees, how often they were victimized or victimized others in stated way. The scale consists of two factors; Doing cyberbullying and Experiencing cyberbullying, and Cronbach Alpha is 0.82), *Attitudes towards reading scale* (constructed for this research; consisting of 17 items, claims that describe opinions about reading. Participants estimated how much they agree with said claims on Likert scale of 7 degrees. Cronbach Alpha is 0.804) and questions about their internet usage and reading habits (how many hours per day they use internet, do they use internet to communicate with people they don't know personally, did they ever meet some of such people, how often they are playing computer games, how much they like to read and how do they estimate the quality of their reading skills). They were also asked to give the information about their school grades from different school subjects, from which their average school grade was calculated. This questionnaire was applied in school, time given for filling the questionnaire was 45 minutes, and anonymity was guaranteed to all participants. Informed consent was also previously obtained from their parents.

3. RESULTS AND ACHIEVEMENTS

Descriptive indicators of used variables can be seen in Table 1.

3.1. Correlations between reading habits, attitudes towards reading and cyberbullying

As can be seen in Table 2, there is a significant positive correlation between academic success, how much pupils like to read and their estimation of the quality of their reading. Variables of reading are positively intercorrelated and so are variables of doing and experiencing cyberbullying, which are also related to how often they play computer games. Pupils who have more positive attitudes towards reading have better grades and are less likely to be cyberbullies.

Table 1. Descriptive indicators of used variables

	N	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Liking to read	263	1	7	4,12	1,765
Estimated quality of reading	263	1	7	5,56	1,277
Frequency of playing computer games	263	1	5	3,34	1,253
Average school grade	263	2,20	5,00	4,0759	0,64264
Attitudes towards reading	257	1,94	5,00	3,4694	0,63533
Experiencing cyberbullying	261	1,00	4,20	1,4218	0,52296
Doing cyberbullying	261	1,00	3,70	1,2540	0,44665

Table 2. Correlations between used variables

	Estimated quality of reading	Average school grade	Attitudes towards reading	Doing cyberbullying	Frequency of playing computer games
Liking to read	,366**	,191**	,660**	-,198**	-,016**
Estimated quality of reading	1	,269**	,349**	-0,102	0,034
Average school grade		1	,261**	-0,087	0,016
Attitudes towards reading			1	-,196**	-0,109
Experiencing cyberbullying				,682**	,133*

** p<0,05; ** p<0,01*

3.2. Gender differences

T-tests for independent samples showed that boys were more likely to be cyberbullies ($t(259)=3,563$; $p<0,01$) and victims of cyberbullying ($t(259)=2,584$; $p<0,01$), while girls had better grades ($t(261)=-3,493$; $p<0,01$), liked to read more ($t(261)=-4,768$; $p<0,01$) and had more positive attitudes towards reading ($t(255)=-3,588$; $p<0,01$).

3.3. Internet usage habits

Pupils who spend between one and three hours per day on internet like to read more ($F(2,257)=4,613$; $p<0,05$), have better grades ($F(3,362)=4,613$; $p<0,05$) and more positive attitudes towards reading ($F(2,253)=5,830$; $p<0,01$) than pupils who use internet more or less time per day. The more they use internet daily, the more they play computer games ($F(2, 257)=11,385$; $p<0,01$) and are more likely to be cyberbullies ($F(2,256)=7,407$; $p<0,01$) and victims of cyberbullying ($F(2,257)=6,367$; $p<0,01$). Pupils who communicate via internet only with persons they know personally have more positive attitudes towards reading ($F(2,249)=3,760$; $p<0,05$) and are less likely to be cyerbullies ($F(2,253)=33,451$; $p<0,01$) and victims of cyberbullying ($F(2,253)=30,099$; $p<0,01$) than those who communicate with persons they don't know personally. Pupils who went to meet someone they knew only through internet have more negative attitudes towards reading ($F(2,253)=4,429$; $p<0,05$), are more likely to do ($F(2,257)=33,455$; $p<0,01$) or experience cyberbulling ($F(2,257)=29,089$; $p<0,01$) and like to read less ($F(2,258)=4,691$; $p<0,01$) than those who didn't go to meet their "virtual friends".

4. CONCLUSIONS

This research, whose aim was to examine are being exposed to cyberbullying and being a cyberbully related to academic success and attitudes towards reading, as much as other researches dealing with the growing problem of cyber violence among children (and adults), has a valuable practical use. The necessity of educating children about dangers of internet, its adequate usage and consequences of cyberbullying is clear, and reading habits might be a protective factor in accomplishing that. Therefore, it is necessary to accentuate the value of adequate reading habits and positive attitudes towards reading in the education process, from its very beginnings.

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Information system for linear asset management

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Abstract

Business organizations are source of hudge amount of data. If these data can be translated in bounded assembly indicators, they will show its exact position in business environment. Based on these enviromental data, the effective business information system will provide informations for management of business system to given goals. Informations has been made in good prepared business information system which has been adjusted with business organization needs. Prerequisites for effective information system creation are known functional and non-functional requirements on information system as part of user specification.

In this paper, after analyses, the demands which has been fitted on information asset management maintenance sytem has been unrooted in system on specific assets like linear asset management. Also, the most significant worldwide software solution for this problems, has been shown.

Keywords: Computer applications; Functional requirements.

1. INTRODUCTION

Continuously increasing information demand, about internal business performance, competition performance, economical movement in some sectors and in economy in general, more and more become the usual need for business organisations, investors, creditors, revision, analists and many other users. It tells us that the decision making by "feeling" in business organisations, in dynamic global, competetive enviroment terms, is irretrievable past. Today a business decisions are based upon exact analasys and calculations which comes out from information systems. Global crisis has increase the demand for business informations even more.

Asset is one of the prerequisite for business and asset management results has significant impact on total business results. Linear assets like roads or railway tracks are special kind of assets from information needs aspect. Classic asset is characterised by simple identification with bar code. On the other hand, linear asset is characterised with spacial dimension and performance which has huge impact on troughput. This paper is dealing with requirements which has been installed on software solutions which has been used as necessary tools for linear asset management as part of railway business information system.

Demands for linear asset management comes out from its complexity and its role in economy. Linear assets like roads or railway tracks has a huge role in economy and society development. Because of that, the high security and availability is expected and also proper return of investment (ROI) which is ensured with software aided linear asset management maintenance. Complexity of assets can be seen on railway tracks example. This asset is made from more spacial distributed, but functional conected groups of elements in business systems with legacy information systems.

It is necessary to incorporate software solution for linear asset management into existing business system.

2. LINEAR ASSET MANAGEMENT PROBLEMS

Most of the citizens are not aware of fact that traffic corridors are one of the most important part of our economy. All the material goods –

food, chlothes, medicine, fuel and all others consumer goods have been delivered to us from some other place. As we have already mentioned, high security and availability has been expected from linear asset so th all material goods can be delivered on specific place in specific time. To achieve this expectations, all linear asset managers, especially railway managers, must deal with four basic questions:

- linear asset capacity;
- operability and reliability of linear asset;
- structure and competitivity of linear asset;
- security of linear asset.

Nowdays, in dynamic, global, competetive enviroment conditions, the 24/7 availability of linear assets is required. Linear asset management become more and more complex, but due to information technology progress, it become possible. To achive optimal linear asset management it is necessary to connect informational technology with phisical infrastructure apropos change the traditional approach of management in more efficient one which can be seen on table 1.:

Table 1. Traditional and smarter approach

No	Traditional approach	Smarter approach
1.	Instinct and intuition	Fact based
2.	Corective	Directive
3.	Years, months, days	Hours, minutes, seconds
4.	Decision aided	Action aided
5.	Efficiency	Optimization

When the linear asset management system is in developing phase, we must always have in mind that the linear assets are assets that must be maintained and all the other asset have one goal – to maintain linear asset. Train pass over linear asset must be payed as fee. The question is:"What is costs of maintenance for every each part of linear assets?". We must know that if we want to set the right fee price. To reach that, we need to split linear asset in small parts as small systems and subsystems. We can do that if we devide linear asset as small sections. Also, we must connect all the work, material and services as cost places. That means that the linear asset management system must support procesess of linear management and human resoursces management. For that reason, linear asset management system is one complex system and it is not easy to implement in companies.

3. REQUIREMENTS

Linear Asset Management systems must contain subsystems for other asset management like real estate and human recource management [1]. Due to effective system work, it must fulfill some logical and configurational requirements including operational, business and ad-hoc reports:

Logical system levels:

- hierarchy of location;
- modelling of funds and the establishment of relationships between individual pieces of equipment, location and system dependent system;
- analysis of cost at the level of locations, systems and subsystems;

System configurability:

- ability to support multiple organizations and locations based on a central database;
- possibility of implementation and adaptation of workflow activity based on the level of work units;
- configuration availability of data field in order to prevent entry of invalid values;

Flexibility and adaptability of the system:

- monitoring and management of various categories of assets such as buildings (capital assets), vehicle fleet, IT and other assets;
- system must support the use of barcodes (system must support the interface with the RFID functionality);
- allows users self-registration;

Monitoring of the life cycle of resources and materials

Immediately after the installation, the system must support the maintenance process, input of assets and equipment involved in the maintenance process, and provide detailed tracking history of the cost incurred, events and trends. The system must also be able to show correctly, current state and conditions of individual assets and their operational status.

The system should be designed to support the continuous updating of the history of the life cycle individual assets and materials, and provide a standardized listing of resources and equipment, and their existing and future attributes.

Managing linear assets

System management and monitoring infrastructure of CRI-a must support the managing linear assets such as:

- lower structures (bridges, tunnels, platforms, platform overheads, CPL, etc.);
- upper structures (rails, sleepers, railway or tramway track accessories, curtains, switches, etc.);
- signaling equipment (automatic railway blocks, various relay, electromechanical and mechanical appliances, railway autostop devices, etc.)

Performance management and Management Information

The system must support the management of work related to all aspects of maintenance funds, from initial request to create a working application, to analysis of results and work. The system must provide:

- Tracking maintenance costs
- Perform preventive maintenance - preventive maintenance means and mechanism to monitor and predict failures before they actually occur
- Connecting interdependent work orders

Management of funds, materials, replacement parts and inventory

Managing of materials, replacement parts and inventory must be based on accurate tracking of materials and its usability, and reduce inventory and better procurement planning. The system must enable optimization of inventory and provide mechanisms for planning requirements, such as dynamic planning, ABC analysis etc. Requisition and planning of resource, materials and spare parts in the system must be integrated with the public procurement process in SAP. All transactions and movement of funds, materials, spare parts and inventory must be entered into the system when they occur. At the process level, the activities must be integrated and supported during the Workflow.

Fleet management

Member's fleet that needs to be monitored is comprised of various mechanization and passenger vehicles and small machinery required for the maintenance of railway infrastructure. The entire fleet management must support the acquisition, agreement management and agreement of service level, warranty periods, and certification of labor force. System must enable integration with the GPS system together with integrated system for trip management.

IT resources management

The system must allow full IT assets management based on the inventory interdependence financial details, maintenance and contract maintenance of IT assets [4]. The system must allow automatic tracking and effective management of the complete IT assets life cycle. The system must be completely compliant for AUDIT with dynamic report system. The system has to have the capability of automated and dynamic monitoring and display of relevant business events in the IT environment. The system has to have the ability to consolidate business and IT assets on company level. The system has to be a part of the overall solution for asset maintenance and monitoring.

Real estate management

Huge number of real estate from housing and office buildings to warehouses, railway stations and buildings that are located directly along the railway line. Better insight into the efficiency and status of certain objects is needed so users can better manage existing space to make quality strategic decisions in terms of maintenance and rental costs, and reduce costs associated with maintenance and rentals. In this sense the system must allow quick access to information about real estate, to the level of monitoring of individual assets within each property. It is necessary to give a good insight into the occupation of commercial residential buildings, and monitor the utilization of certain spaces (buildings, floors, housing, etc.).

4. COMPARISON SOFTWARE ASSET MANAGEMENT - SAM

Demand for asset management software has been an opportunity for the players of the ERP market to develop special modules for the asset management on railway companies. Companies such as Infor, IBM, Invensys, SAP and Oracle have adapted their integrated solutions to the specific needs of this sector and have positioned them on the linear asset management segment [5] with relations as shawn on Fig 1.

Fig. 1. Comparison SAM [2]

IBM Maximo LAM is one of the applications which permit asset management based on a linear model. Thus, the dynamic segmentation of the line (km or mile) includes "Features" which can be used to show level crossings or signals, "Attributes", which can be used to show speed, ballast type or track number and "Linear relationships", indicating intersections, or parallel track or roads. Hierarchical assets, such as stations, bridges and tunnels, can also be modelled in the same database.

5. CONCLUSION

Asset management now days enforce itself as a significant factor of total company success. Beside companies, many associations have found out the need for this kind of asset management concept. During 2006. International Organization for Standardization has started with asset management software standardization with specific goal that every company must have ability to get the best practice in asset management. UIC (International Union of Railways) and CER (Community of European Railways) have founded special department threw EIM (European Infrastructure Managers) which is going to deal with strategy development for managing railways assets in Europe.

Now days, asset management systems must comprise strategic goals, all assets data, property condition, failure forecast, engineers and analytical tools etc. [3]. As we can see, this is much more than just simple book keeping.

We can say, with certainty, that linear asset management with special software, is one detachment from traditional asset management where single examinations of assets took place (parts of road, bridges, etc.) each other for itself. This kind of system enable us connection of all single parts of linear assets into one ''living organism'' which can be maintained from one place and with constraint budget. With this kind of asset management, better infrastructure quality, better data accessibility of each linear asset part, better investment decision making and total maintaining cost decreasing can be achieved.

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Assessing the effectiveness of investments from the perspective of two systems - economy and ecology

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Abstract

An economic system is still trying to satisfy the growing needs of customers by transforming natural resources for a comprehensive range of products on the market. If we want to preserve natural heritage resources for future generations, it is necessary to make changes in the identification and meeting needs. That means for companies to identify with the concepts of sustainable development and CSR. Companies must realize that the economic evaluation of their investment should not miss the ecological evaluation. For the company must not be economically advantageous to pay penalties and taxes for environmental pollution, but use other, more efficient and economical instruments for environmental protection. The priority objective of companies should become sustainable (sustainable profit) and preserve opportunities for further development and prosperity in the effective use of natural resources. ***This work was supported by the Slovak Research and Development Agency under the contract No. LPP-0384-09: „Concept of the HSC model 3E vs. Concept of the Corporate Social Responsibility (CSR).“***

Keywords: Investments; Environment; Efficiency.

1. INTRODUCTION

The economy has now become a system that is closely related to ecology and environment. Dependence of the two systems largely affects the economic efficiency of each company. The behavior of businesses in the market environment is aimed at addressing the main objectives of product policy. These relate to their competitiveness and to ensure long-term earnings and profitability.

Personal and social welfare is measured almost exclusively by volume growth, the economy is experiencing. Increased production and consumption are good. Less production and consumption are bad. It is that simple. Now it's time to free ourselves from the mythic quest for economic growth. Humanity needs a new economic myth is based on the interconnected global community that works in harmony with nature. [1]

Ecological awareness of the population produces a change of values and creates new dimensions of consumer behavior. At the forefront of consumers to receive particular environmental aspects of the manufacturing process, supply, waste disposal and so on. Ecological challenges concerning the comprehensive range of products on the market, creating pressure to change consumption patterns towards the environmentally-friendly products. From this we can conclude that the behavior of business entities in this case responds to the requirements of environmental markets. It is important that the company has recognized this fact and acted for the benefit of their planet. Managers must be ready to to carry out such strategic decisions that are as economically successful as well as environmentally sensitive.

2. THE NECCESSITY OF ENVIRONMENTAL THINKING

At present, already aware of the need and importance of a healthy environment. We can talk about some sort of "environmental trends" that influence us - we are talking about organic products and production, environmental organizations, ecological environment, etc. But we must not forget that not nature, but we do stand for a number of global changes. Today we would not be seen as a momentary trend, but as a permanent identification with the principles (sustainable development and CSR). In practice this means for us to learn how environmental impacts actively managed, thus protecting the environment and eliminate the damage it has already caused.

A very important factor in efforts to achieve sustainable development and environmental protection is a consistent, meaningful and interdisciplinary education of the population on this issue. This training and education should be focused on awareness, motivation and knowledge of all population groups. Environmental education is to build a positive emotional relationship to the human environment, it should show the way to the lifestyle of ecological principles and sustainable development. [2]

The benefits of environmentally oriented production:

- Cost savings (fuel costs and energy costs and raw material, transportation costs, processing costs respectively. Waste disposal)
- Reduction of loss, damage and risk (reducing losses from unrealized production, reduce environmental damage, reduce accidents and diseases, disorders and minimize the occurrence of accidents)
- Increased competitiveness (Anticipation and compliance with market requirements, product innovation and process flexibility in meeting the supply, easier application to new markets)
- Increase business culture (improving the image of the company, the reliability and credibility of company, motivation to work with companies' conformance with applicable laws, higher qualification of company, a better relationship with the company and trade mark).

Environmental education should become a priority, as well as all companies. Learning companies' environment in our mind is the first step to change from "non-organic to organic."

3. THE INTRODUCTION OF EMS

Traditional business objectives are focused on ensuring long-term competitiveness of profit making. Companies should be aware however, that environmental protection is a factor in long-term economic success and a tool of competitive advantage in a competitive market.

Environmental management system management system (EMS) provides a way to optimize the manufacturing process, and how to achieve economic and environmental harmonization. Its implementation requires certain costs, but they are ultimately recoverable investment. Another positive aspect of EMS is that it increases economic efficiency and improving business environmental performance company acquires new profit potential. Through environmental management is necessary to carry out business activities in overcoming the contradictions between the market, society and the environment.

EMS helps reduce the cost of environmental pollution and increasing the competitiveness of companies in the market. EMS certification is a prerequisite, to foster environmental awareness in business and development activities towards the overall quality of life. It is a means of effective financial and economic analysis and allows formulating goals. It is a valuable communication tool that creates an ethical relationship of trust and confidence between business partners, customers and society. These are the reasons why the presence of EMS for the company is important, and why it may be useful for the company.

4. IDENTIFICATION WITH THE CONCEPTS OF SUSTAINABLE DEVELOPMENT AND CSR

Sustainable development is enshrined in the legal system of the Slovak Republic as a development that ensures the basic needs of individuals and society today without compromising the environmental conditions and the ability of future generations to meet their own needs. The strategic objective of sustainable development is the harmonious reconciliation of economic growth, social justice and accountability, and ultimately the environment.

In practice, sustainable development requires adherence to certain rules [3]:

- Saving policies, which means in particular of waste in preference to short-durable goods and non-reusable (forming waste), reduce losses and so on.,
- Recycling of used materials and products, saving resources and reducing pollution around waste,
- The use of renewable energy sources and prioritizing natural materials and products
- Control population, t. j. stabilize the population carrying capacity, which is able to sustain the Earth.

Businesses and other institutions should follow those rules and invest their money in environmental protection. For business, it is obvious that investment is spent primarily for their economic return. He would not be their sole purpose. It is therefore important that companies embrace the concept of sustainable development and identified themselves with him.

CSR - Corporate Social Responsibility brings a new perspective on the societal role of business awareness of the link between profitability and environmental standards of ethical business. Companies are focusing increasingly on environmental protection (environmental), local community development, ethical business, improving relationships with employees and partners. Corporate social responsibility can be considered a source of competitive advantage and innovation to help businesses remain on the market. Companies wishing to successfully develop their activities should be increasingly involved in engaging all key partners in the socially responsible business, whether it relates to the production process, providing quality products and services, employee care, fair access to customers ethical corporate governance, environmental protection, and cooperation and support of the local community. [4]

5. INVESTMENT DECISIONS IN THE COMPANY – USING EXACT METHODS

The essence of the economic approach to analysis and evaluation of investment projects based on the assumption that rational action is to effectively use limited resources to achieve maximum goals, respectively. desired benefits. Methods of evaluation of investment projects showing what the cost-effectiveness differing variants of the decision and, therefore, help to select those investment projects or activities that are best able to contribute to the growth of social welfare.

AHP (Analytical Hierarchical Process) is a method of decomposition of a complex unstructured situation into simpler components - i.e. hierarchical system. Hierarchical system is to expand options multicriterial decision-making system. This method of using pair wise comparisons of each component is assigned numerical values that reflect their relevant importance. Synthesis of these assessments will then determine the components with the highest priority, which is then directed the operation in order to obtain the solution of the decision problem. [5]

AHP can be used in several different areas such as government, commerce, industry, health, education. This method can thus be used in evaluating an investment in the company. This is a decision-making method that adapts to hard data, such as. price, delivery speed, as well as personal experience and, finally, intuition. Allows you to mathematically derive the weights of the criteria rather than subjective selection criteria were weighted.

A similar method as the method of AHP is the CBA, thus yield-cost analysis (cost-benefit analysis). This method serves to evaluate and assess the project by comparing the benefits and costs.

CBA is used for the evaluation of investment projects that are intended not only to quantify the financial cost of the project and the revenues that flow from it and financially but also to assess any additional social benefits (eg improving the health status of residents, boost tourism, environmental impact environment, etc.). CBA makes it possible to evaluate the advantage also of investment projects that ultimately do not profit (public nature of projects). Featuring the indirect benefits of financial flows is possible to assess the suitability of financial investment, although its main purpose is not social benefits and financial return.

The problem with CBA and AHP methods is that in practice it is very difficult to determine and quantify the benefits and costs of the project, and then express them in monetary terms, because a number of effects deriving from the non-financial investments and sometimes intangible nature. In evaluating the project is therefore a key factor in investor income, but social benefit is calculated as the difference between project costs and revenues incurred by its implementation.

It's time to call on businesses to the investment decisions made on a project to attach importance to social benefits, which flows from the project, and are not only an economic return on investment.

6. CONCLUSION

Ecology and economy are interdependent systems are uniform in their mission of serving society. In the economic evaluation of the company's results should not miss the environmental assessment of t. j. operation of production and product quality of air, water, soil and under. Benefits for manufacturing companies should be climate-friendly investments and introducing new environmental instruments.

Important role in issues of environmental protection plays just the corporate sector. Companies are increasingly focused on managing the impacts of their activities, products and services on the environment. The priority objective of sustainability is becoming a business and maintaining the option of further development and prosperity in the effective use of natural resources. Those companies that realize that continued economic growth in profits in productivity is impractical due to the limitation of natural resources, teach their employees (consumers) to the new environmentally oriented values. Such businesses are environmentally oriented, aware of the benefits of EMS implementation, identify their corporate culture with concepts of sustainable development and CSR, and also making an investment decision seen as an economic and environmental evaluation of their investment.

The developed world has come to the realization that it is necessary to combine the positive economy and environmental protection. Moreover, it showed that this integration is possible and desirable. This approach characterizes the password of the Commission for the integration of OECD economies and the environment: "A strong economy requires a healthy environment and a healthy environment requires a strong economy." [6]

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Necessity of motivation to ensure the sustainable development of industrial companies

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Abstract

Fundamental role of industrial companies is to motivate an employee in such a way as possible to participate in fulfilling the objectives of the organization. In the case of modern industrial companies is not only to profit but to ensure sustainable development in the long run. Achievements of organization in the environmental and social area, support economic success and vice versa. It is therefore necessary to set up a system of employee motivation in order to provide a stable economic, environmental and social development of industrial companies. ***This work was supported by the Slovak Research and Development Agency under the contract No. LPP-0384-09: „Concept of the HSC model 3E vs. Concept of the Corporate Social Responsibility (CSR).“***

Keywords: Motivation; Sustainable development; Human resources.

1. INTRODUCTION

Sustainable development can be characterized as such a development that allows for meeting the needs of present generations without prejudicing the rights of future generations to meet their needs. [1]

The concept of sustainable development is based on three pillars: economic, environmental and social. All these pillars connect people and their needs. Satisfying needs is for people in the first place. Necessary to encourage a man to progress and development. Motivation for socially responsible behavior, and thereby to sustainable development is complex because not bring direct and immediate result.

Only a change in values and revision of priorities for human society can ensure sustainable development.

2. MOTIVATION – THE POSSIBILITY OF ENSURING SUSTAINABLE DEVELOPMENT

Suitable work motivation is a fundamental prerequisite the success of organizations in the market because only suitably motivated worker can be given consistently high performance. "The strategic manager Ernest Bader at 30 the last century said that more salary or better working conditions can not be morally deal of pride in skills, social recognition and praise, promotion and free expression of personality and initiative."[2] The objective of managers is to apply a motivational tool for workers to be willing and able to be given high performance. However, it is necessary that managers have been identified with the principles of sustainable development, and that their internal beliefs passed on to subordinates.

We distinguish between two basic types of motivation:

- inner motivation - man creates this incentive itself and it consists of responsibility, ambition, self-realization ...

- external motivation - external motivation to form an organization (manager). This can be divided into positive - bonuses, salary increases, praise and negative - reduction in salary, reprimand ...

In any case, it is beneficial for both the organization and for society when prevails inner motivation. Thus, if workers are in leadership positions believe a meaningful concept of sustainable development, they should use all available means to bring this to prove their beliefs to others.

Individual needs that lead people to action are clearly displayed and distributed in Maslow's hierarchy of needs.

Fig. 1. Maslow's Hierarchy of Needs Chart [2]

a) Basic needs are physiological needs and safety needs could be attributed primarily to the environmental pillar. Increasing distortion of the environment will occur only to problems with ensuring basic food sufficiently, but most will be no reduction in drinking water and reduce air quality. There is no denying the impact of industry as the largest polluter. Industry falls under the economic pillar. Need for certainty is now understood primarily as material security safeguard factor that brings certainty to housing, food and living standards.

b) Relationship needs are characterized by solidarity belong to the social pillar. Have always been people need to join together into groups. In these groups were created social relationships, and these groups are spread out over share, combine, or extinct. This is with smaller or larger changes to be passed now and nothing on it or changed by globalization. The economic conditions significantly affected inclusion of man to various groups. Financial status will automatically be assigned human to social group. Thus, the impact of the economic pillar can not be denied.

c) Development needs including the esteem needs and self-actualization, we could assign to the social pillar. Respect and recognition is closely related to social status, success stories, now understood through material goods.

A survey by the MVK agency, sixty percent of people consider money as the best incentive to work. [4]

It follows that the main motivator in the Slovak Republic is money. These procedures affect not only workers but also managers. This is the situation in which there is labor market in Slovakia, but also the values of society.
But still remains 40% of people for whom there is no money in the first place. In this case, may come to the forefront manager skills and abilities. This should be a role model and positive influence proceedings subordinates, clarify the need for sustainable development. Workers must be seen benefits from the concept of sustainable development that may not be immediate but long-term stable.

3. CSR – THE WAY TO SUSTAINABLE DEVELOPMENT

CSR (Corporate Social Responsibility) brings a new perspective on the societal role of business awareness of the link between profitability and environmental standards of ethical business. Companies are focusing increasingly on environmental protection (environmental), local community development, ethical business, improving relationships with employees and partners. Corporate social responsibility can be considered a source of competitive advantage and innovation to help businesses remain on the market. [5]

4. CONCLUSION

Sustainable development is for most people, mainly the environmental pillar and environmental protection, social responsibility can be. But people do not contest economics. Time in which we live is characterized by a market economy, globalization and open markets worldwide, which are controlled by money. It says the economic pillar can not be acknowledged, because each organization is addressed how much it will cost and what it can bring us. Suitable selected corporate culture, corporate social responsibility organization and motivation towards sustainable development organizations deliver sustainable profits. On top of the organization must stand aware, educated and responsible managers, who will be role models for their subordinates.

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Enterprise 2020 – challenge for schools, universities and commercial practice I.

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Abstract

The content of the paper concerns to critical and systematic analysis of current state of applied concept of sustainability of our planet Earth, a brief characteristics of document Enterprise 2020, analysis of actual reactions to the document and also our contribution to the challenge Enterprise 2020. This first part of the fourth-part paper deals with critical and systematic analysis of current state of applied concept of sustainability of our planet Earth. ***This paper was supported by the Slovak Research and Development Agency under the contract No. LPP-0384-09: "Concept HCS model 3E vs. Concept Corporate Social Responsibility (CSR)." The paper is also a part of submitted KEGA project No. 037STU-4/2012 "Implementation of the subject "Corporate Social Responsibility Entrepreneurship" into the study programme Industrial management in the second degree at MTF STU Trnava".***

Keywords: Education; Training; Sustainable Development.

1. INTRODUCTION

Sustainable development concept as next in the text described that creation strated in about 80. years in last century. It is a concept which is based on the creating of opportunities for present generation with the respect at to sustain conditions for next generations. It's about conditions mainly in economic, social and environmental criteria. This means, that don't consider only economic parameters as the only ones respectively as the most important but it consider also the next both parameters of sustainable development. Since the creation has undergone several changes and applications in praxis but the base stays unchanged. The base of this concept is also the status quo, that society becomes more and more globalized.

2. EVOLUTION OF THE THEORY IN SUSTAINABLE DEVELOPMENT CONCEPT

"Sustainable development" (SD) concept was originally derived from ecology, first appeared in **"The World Conservation Outline"** formulated by the International Union for the Conservation of Nature and Natural Resources (IUCN) in March 1980 [1].

The term sustainable development began to gain wide acceptance in the late 1980s, after its appearance in Our Common Future, also known as The Brundtland Report. The result of a UN-convened commission created to propose "a global agenda for change" in the concept and practices of development, the report signalled the urgency of re-thinking our ways of living and governing [2]. Subsequently, the concept is widely applied in areas of economics and sociology, its connotation are expanding, and has up to now become an integrative and dynamic concept related to economics, society, culture, technology and natural environment. During the process of formation and development, the concept and the meaning definition of sustainable development created different schools of thought.

The more influential schools are as follows [1]:

- ***In November 1991, the International Association for Ecology and the International Union of Biological Sciences defined sustainable development as:*** the production and renovation capacity of protecting and enhancing the environmental system. They think that sustainable development is to find a best ecological system so as to support the ecological integrity and the realization of human desire, and then to sustain human living environment.

- In 1991, the IUCN, United States Environment Programme (UNEP) and the World Wildlife Foundation published “Caring For the Earth: A strategy for Sustainable Living” (referred to as "survival strategy"), in which sustainable development is defined as: “In the condition that the survival does not exceed the carrying capacity of the ecosystem maintenance, to improve the quality of human life”. Which, namely, emphasizes that human production and life style need to maintain a balance with the carrying capacity of the earth as to protect the earth's vitality and biological diversity.

Two points are essential to sustainable development. First, the realisation that economic growth alone is not enough to solve the world’s problems: the economic, social and environmental aspects of any action are interconnected. Considering only one of these at a time leads to errors in judgment and “unsustainable” outcomes. Focusing only on profit margins, for example, has historically led to social and environmental damages that cost society in the long run. But taking care of the environment and providing the services that people need depends at least in part on economic resources.

Next, the interconnected nature of sustainable development calls for going beyond borders, whether they be geographical or institutional, to co-ordinate strategies and make good decisions. Problems are rarely contained within predefined jurisdictions such as one government agency or a single neighbourhood, and intelligent solutions require co-operation as part of the decision-making process.

At the core of sustainable development is the need to consider “three pillars” *together:* society, the economy and the environment. No matter the context, the basic idea remains the same – people, habitats and economic systems are inter-related. We may be able to ignore that interdependence for a few years or decades, but history has shown that before long we are reminded of it by some type of alarm or crisis.

Each country’s historical, economic, social and political context is unique, but the basic principles of sustainable development apply to all. Economic growth is essential, but growth alone, without understanding all the factors that contribute to well-being, does not reduce poverty sustainable. Economic growth generally correlates with overall improvements in quality of life, higher levels of education and life expectancy at the country level, but this does not tell us how this growth is achieved; whether or not it is lasting; and who benefits or is left behind [2].

3. THE CONNOTATION OF MODERN CORPORATE SOCIAL RESPONSIBILITY

Generally speaking, the connotation of modern corporate social responsibility is as follows:

- Enterprise’s social responsibility to investors. This is the most basic social responsibility to

Enterprises. That is, enterprises should preserve and increase the value of assets, and improve returns on capital by maximizing the profit so as to ensure the investors’ legitimate interests in the enterprise.

- Enterprise’s social responsibility to the government. This is also the basic social responsibility of enterprises. That is, enterprises must follow the relevant government laws and regulations, pay taxes and assume other responsibilities and obligations stipulated by the government, and accept government intervention and supervision according to law, and not tax evasion, tax dodging and illegal tax avoidance.

- Enterprise’s social responsibility to employees. This means that enterprises need to assume the obligations relative to employees’ welfare, safety and education and the like.

- Enterprise’s social responsibility to consumers. That is, to fulfil the promises on product quality or service commitment to consumers, to ensure to provide consumers with high quality products and satisfactory service, not to fraud consumer and not to seek exorbitant profits.

- Enterprise’s social responsibility to creditors. That is, to repay the capital with interest on time in accordance with contract, and to ensure the security and legal benefits of creditors.

- Enterprise's social responsibility to society. This mainly means that enterprise would assume the responsibilities related to social philanthropy, public welfare, and social and environment sustainable development to society.

4. INTERGENERATIONAL EQUITY

The 1987 Brundtland Report defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

Sustainable development broadly requires that the well being of the present generation should not be increased at the expense of welfare of future generations, and society's well being should not decline over time. The next generation can only produce as much well being as the present one if it has the same stock of capital available to it. To put it in simple terms, sustainability implies `living off the interest', rather than `living off the capital'.

The capital stock can be thought of as comprising three kinds of capital:

- ***natural capital*** such as forests, air, water, soils and biodiversity (normally referred to as environmental resources) and other resources like minerals;

- ***human capital*** such as human resources, skills, and knowledge;

- ***human-made capital*** such as manufactured capital and goods, machinery, infrastructure, buildings, etc;

- ***weak sustainability***, where it substitutes natural capital with human, or human-made capital (e.g. it depletes half of its primary forests to build factories, tourist resorts and schools);

- ***strong sustainability***, where it does not substitute natural capital with other forms (e.g. it conserves a permanent estate of primary forest).

5. EDUCATION AND TRAINING FOR SUSTAINABLE DEVELOPMENT

Education which leads either individuals or group to the principles of SD is one of the basic prerequisites for the effective functioning of this system in real conditions. Where, when, who and how should be this education for SD processed are the basic questions that should be given and seek answers to them if we want to take this way. The same is in the world as in our country – Slovakia are created a lot of initiatives that have decided to go this way and are more or less successful in meeting the objectives of SD and that is namely the creation of such conditions of the life on the Earth to ensure to future generations the same opportunities as those of current generation.

European Council issued such documents: **"The EU Sustainable Development Strategy"** as well as **"The United Nations Decade of Education for Sustainable Development"** hereinafter **"The Recommendation of the European Parliament and the Council of 18 December 2006 on key competences for lifelong learning"**, **"The strategic framework for European Cooperation in education and training (ET 2020)"** and last but not least **"The Europe 2020 Strategy for jobs and growth"**. In these documents but also in many others can be found the answers to following questions:

1st question: "Where should educate resp. train to SD?"

The answer to this question should be clarified especially by such institutes like multinational, national or local communities that seek to respect the principles of SD. That is to say for example the European Union which should develop organizations within the initiatives leading to SD, such that would provide some kinds of education and training. It would act mainly on some type of organization providing public services. These should be funded directly by the EU and should also be a kind of liaison officer resp. parent or supporting organization for national as well as local offices.

In Slovakia the ongoing education and training to SD in all institutes which have and may have some kind of business in this field. Since kindergarten some of which are focused on education and training of children especially in the field of environmental protection as well as primary schools where we can meet with little groups managed outside the school schedule to this subject, continuing with secondary schools and universities. What concerned the universities in last years began the progress in number of projects whose basic idea is the education and training whether students, corporate employees or the general public for SD.

Of course, the ideal situation will be when all individuals from the kindergarten to the and of the high school or the university are faced with this issue and are actively involved in it. Very large role in this cycle have mainly various organizations working with children and youth which does have the greatest potential to become leaders in the field of education and training of individuals as well as of groups in SD. Matter of fact, this activity can do for those who voluntarily decided and it is therefore a non-violent form which will the majority prefer.

2nd question: "When should the education and training to SD begin"?

The answer to this question can be found in the answer to the first question, so with the education and training for SD should begin as soon as possible for example in the kindergarten. However, please be aware that there can be trained only few parts of the training. In essence, it could look like so that in kindergarten will be the education and training oriented mainly to the environment protection and of course with partial lessons for understanding of social dimension of the SD. This social dimension, however, more can be managed in primary schools. And the economical dimension especially in the secondary school and then on the universities. The ideal situation is to integrate all three dimensions but it may be possible in some higher educational degrees of primary school and then on secondary schools.

3rd question: "Whom should we train and educate towards to SD"?

For SD should we educate every individual and every group. Individuals according to the lifelong education – kindergarten, primary, secondary school and university. But it is also necessary to educate the groups. How? This is the most important question. If this is a group within the company that has applied the principles of SD in their system, so there is a possibility hold regular training sessions in which issues relating to SD will be discussed. Other groups, however formal or informal can be educated through various organizations.

4th question: "How should be education and training for SD running"?

Also the answer on this question can be partially found in the answer to previous question. It should deals with two forms. Formal and informal. The formal takes place within the prescribed subjects on various types of schools. However the informal may take place in different projects with the main objective to provide the education and training. In practice in Slovakia or in the world such initiatives are occurred in last years more and more.

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Enterprise 2020 – challenge for schools, universities and commercial practice II.

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Abstract

The content of the paper concerns to critical and systematic analysis of current state of applied concept of sustainability of our planet Earth, a brief characteristics of document Enterprise 2020, analysis of actual reactions to the document and also our contribution to the challenge Enterprise 2020. This second part of the fourth-part paper deals with the initiative Enterprise 2020, its characteristics and importance for school and universities. ***This paper was supported by the Slovak Research and Development Agency under the contract No. LPP-0384-09: "Concept HCS model 3E vs. Concept Corporate Social Responsibility (CSR)." The paper is also a part of submitted KEGA project No. 037STU-4/2012 "Implementation of the subject "Corporate Social Responsibility Entrepreneurship" into the study programme Industrial management in the second degree at MTF STU Trnava".***

Keywords: Enterprise 2020; Sustainable Development; Corporate Social Responsibility; Universities; Partnerships.

1. INTRODUCTION

Current state of our planet and life on it force us to implement ideas of sustainable development and corporate social responsibility not only on the business level but also at schools and universities. Education to sustainable development should start as soon as possible – at least at universities. It's because universities represent the institutions where the future business leaders are educated. Academic institutions play the integral part of corporate social responsibility publicity.

The paper describes the new initiative Enterprise 2020 – points out the most important facts of the initiative that has a goal to reach sustainable economy by making "a company of future" (Enterprise 2020) by engaging the academic institutions as well.

2. ENTERPRISE 2020 – CHALLENGE FOR SCHOOLS, UNIVERSITIES AND COMMERCIAL PRACTICE

Nowadays, in a time of permanent changes, is important to think about how our planet and a life on it will change. CSR Europe, an organization grouping and representing European businesses that reciprocally share and change off practical experiences in a field of corporate social responsibility (CSR), together with European Commission deal with looking for answers on questions like: "How our current patterns of living, working, communicating, learning, consuming and sharing resources will change in the next decades?"

Just last year 2010 European Union headed by European Commission and Council published strategic document strategy Europe 2020 as a successor of unsuccessful Lisbon Strategy.

2.1. Strategy Europe 2020

Strategy Europe 2020 was introduced with the aim to recover from the global economic crisis and prepare the EU economy for the coming decade. The strategy has three key factors of growth that are needed to be implemented through specific arrangements on the EU level as well as on the international level. One of the factors is to achieve smart growth to support knowledge, innovations, education and digital society. The achievement of inclusive growth as the other key factor of growth would be carried out through increasing the participation on labor market, by gaining the crafts and fight against poverty. The third factor is to maintain sustainability growth mainly through increasing effectiveness of the production by increasing competitiveness subsequently [1].

The most important aspect how to reach the stability and sustainable growth is that companies realize that sustainability and responsibility represent the key factors of success. Companies should operate in the way that would contribute to well-being of society and of our planet in particular by positive business solutions.

Just by setting out and application of responsible business principles it´s possible to contribute to improve living conditions on our planet and to support its sustainability. Therefore it must be emphasized the need to transfer of CSR principles to all business activities, to communicate about its impacts and to engage various stakeholders and also universities to its next development. It's important to instill the principles at least on the university level because the academic institutions educate the next generations.

2.2. Enterprise 2020

In Brussels on 28th October 2010 the event Enterprise 2020 MarketPlace participating 70 multinational corporations and 27 national partnership organizations from the whole Europe, including Slovakia, each member of CSR Europe, took place. Together they presented common initiative Enterprise 2020 that was made to solve societal challenges through collaborative action and shape the business contribution to the European Union´s Europe 2020 strategy for smart, sustainable and inclusive growth. The project or initiative is due to support already mentioned strategy Europe 2020 that should help to overcome the recession and prepare economy of European Union for the next decade.

Antonio Preto, Head of Cabinet of European Commission, spoke on the event and emphasized the need of corporate social responsibility principles´ application to business activities, in particular in a time of deep and interlinked social, economic and environmental challenges. He also pointed out that the slogan "CSR is a serious business" it´s a slogan with exactly truthful predicative power. It's because CSR is a business concept highlighting more than ever the huge potential of enterprise to achieve the goal of sustainable development (SD). Antonio Preto also noticed that CSR itself needs to evolve because if it remains a tactical and peripheral concern largely driven by marketing and public relations, it will lose its relevance. CSR must be a part of core business strategy and a vehicle for change, not just an instrument for protecting the status quo [2].

Enterprise 2020 is an initiative for supporting businesses in building sustainable competitiveness, for strengthening cooperation between companies and its stakeholders by exploring new ways of cooperation, and for strengthening Europe´s global leadership on CSR by engaging EU institutions and other stakeholders.

How such an enterprise – „Enterprise in 2020" will look like? The answer on the question can be found in a common vision, where following is listed: ***„The company of the future, Enterprise 2020, operates profitably through mainstreamed responsibility and transparency, and innovates solutions for the planet and its people in close cooperation with stakeholders. Together, they lead the transformation towards smart, sustainable and inclusive society" [3].***

Initiative Enterprise 2020 emphasizes the need of wide partnership where all stakeholders would be involved in within the transformation to innovative, sustainable and smart society and reinforcement of international CSR dimensions. As for the survival of future generations and our planet in wider context partnerships and close cooperation on each level, among governments, companies, civil society, academic institutions and spiritual and cultural communities businesses are important.

Especially universities and other academic institutions should realize the role they play in the process of making partnerships with the commercial practice. These institutions should be prepared to make such and partnership, for example by educating their students in the field of CSR who would be prepared to implement CSR principles to practice.

To educate students to sustainability is important as for the implementation of subjects that would emphasize the sustainable development and CSR principles into tuitional process. At Faculty of Materials Science and Technology SUT in Trnava our aim is to implement a new subject “Sustainable corporate social responsibility” into the study program Industrial Management that would extend theoretical and practical students´ experiences in the field of CSR that could be applied in practice.

It must be known that we all are responsible for the next conditions of our planet. Only by common work and common ambition we can reach more human society and sustainable planet for current and future generations. Such partnerships are key tools in strengthening the global dimension of CSR.

European companies and academic institutions play cardinal role in worldwide criteria of the development of CSR as a strategic tool for making sustainability of world economy.

The goal of strategic initiative Enterprise 2020 is to [3]:

- ***support companies in building sustainable competitiveness*** *by providing a platform for exchange and innovation,*
- ***foster close cooperation between companies and their stakeholders*** *by exploring new ways of working together towards a sustainable future,*
- ***strengthen Europe’s global leadership on CSR*** *by engaging with EU institutions and other global stakeholders.*

Strategic initiative Enterprise 2020 provides an open platform for innovation and exchange through engaging in thematic communities of practice and together helps to develop collaborative ventures.

Engaging in Communities of Practice

The task of initiative Enterprise 2020 is to engage businesses and stakeholders together to look for and use emergent opportunities in various fields, reflecting on current and future trends that create business and society. The practices engage CSR Europe’s corporate members and national partners in various opportunities for learning, sharing and working together with other companies and relevant stakeholders. **The major fields of interest of Communities of Practice formation are following [3]:**

- ***Transforming Markets*** *(Driving sustainable internal and external markets),*
- ***Inclusive Societies*** *(people development and social inclusion),*
- ***Health and Wellbeing*** *(improving quality of life),*
- ***Transparency for Trust*** *(Measuring and communicating environmental, social and governance (ESG) performance)***.**

Developing Collaborative Ventures

Collaborative ventures created in each community of practice address societal challenges through joint leadership and cooperation between companies and stakeholders.

Their goal is to develop thought leadership and practical tools that can be replicated and transferred to other areas and sectors and that can be the basis for new synergies with European and international policy making.

Within the frame of individual fields of communities of practice can be solved following collaborative projects [4]:

- ***Transforming Markets*** *(managing sustainable supply chains, enabling technologies for environmental sustainability, inclusive business models at the base of the pyramid, integrated framework for enterprises energy and environmental policies),*
- ***Inclusive Societies*** *(using potential – jointly tackling demographic change in Europe, European Employee Volunteering Awards, science in schools),*

- ***Health and Wellbeing*** *(health literacy, business contribution to the European Year for Active Ageing),*
- ***Transparency for Trust*** *(valuing non-financial performance, your community footprint, accelerating CSR in state-owned companies, financial capability for Europe's youth and retirees).*

Activities running over initiative Enterprise 2020 reflect the convergence of global trends together with the efforts of business to provide solutions to emerging societal needs. The major accent in the initial phase will be on consolidating communities of practice, facilitating collaborative ventures and developing innovative partnerships [3].

Initiative Enterprise 2020 is oriented to help businesses in following fields [3]:

- ***contribute to improving business competitiveness through CSR leadership,***
- ***strengthen the corporate social responsibility and program of sustainable development through sharing information and partnerships experience*** *(leaderships in CSR field)*
- ***contribute to business to take leading place among European and international movements on CSR***

Enterprise 2020 constitutes also a unique platform for schools and universities that want to cooperate or team up with business to champion responsible management research. The cooperation could be reflected also in developing the capacities of students and executives to be future generators of sustainable value for business and society.

Academic institutions should also play the key role in corporate responsibility promotion.

3. CONCLUSIONS

The paper refers to strategic initiative Enterprise 2020, an open platform for innovation and exchange through engaging in thematic communities of practice and together helps to develop collaborative ventures.

Initiative Enterprise 2020 provides a unique opportunity for universities to put through theory and practice in the field of CSR. We pointed out the importance of universities and other academic institutions engaging in the partnerships with commercial practice in the field of CSR.

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Enterprise 2020 – challenge for schools, universities and commercial practice III.

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Abstract

The content of the paper concerns to critical and systematic analysis of current state of applied concept of sustainability of our planet Earth, a brief characteristics of document Enterprise 2020, analysis of actual reactions to the document and also our contribution to the challenge Enterprise 2020. This third part of the fourth-part paper deals with the actual reactions to the initiative Enterprise 2020. ***This paper was supported by the Slovak Research and Development Agency under the contract No. LPP-0384-09: "Concept HCS model 3E vs. Concept Corporate Social Responsibility (CSR)." The paper is also a part of submitted KEGA project No. 037STU-4/2012 "Implementation of the subject "Corporate Social Responsibility Entrepreneurship" into the study programme Industrial management in the second degree at MTF STU Trnava".***

Keywords: Enterprise 2020; Support; Sustainability; Programs; Award.

1. INTRODUCTION

On Thursday, October 28, in Brussels, the European capital of corporate social responsibility, the CSR event called Europe's Enterprise 2020 Market place event was held. Multinational companies, European institutions and national governments, NGOs and research institutions gathered in the city where the European Commission has its headquarters for one of the most important international events regarding corporate social responsibility (CSR).

The event in Brussels hosted over 400 delegates representing the different bodies which are involved in CSR - companies, institutions and stakeholders gathered at CSR Europe, the largest European network for businesses that are sustainable, responsible and competitive.

The event in Brussels provided an opportunity to learn about the European Commission's CSR projects, as well as about best practices in the field through the direct account of leading figures.

During the Enterprise 2020 MarketPlace, the most innovative CSR initiatives implemented by companies were presented to the public and are divided in four different categories: transforming markets, inclusive companies, health and well-being, trustworthy transparency.

By the paper we want to refer to actual reactions to the document Enterprise 2020 that was first time published on the event Enterprise 2020 Market place in Brussels.

2. ACTUAL REACTIONS TO THE DOCUMENT ENTERPRISE 2020

Initiative Enterprise 2020 is built on fifteen years of business practice, tools development and stakeholder dialogue. It issues from the basis of the European Alliance for CSR initiated in 2006 by the European Commission together with the CSR Europe, BUSINESSEUROPE and UEAPME (European Association on Craft, Small and Medium-Sized Enterprises) [1].

The initiative can be understood as an open invitation for new collective and shared actions to build the responsible company of the future – "Enterprise in 2020".

The aim of it is to contribute to enhance competitiveness through CSR leadership, to strengthen CSR and SD program through sharing information and partnership experiences and to help companies to take leading place in Europe in solving CSR issues.

The goal or the ambition of European members that appeal other nations, businesses, organizations, academic and other institutions is to join to Enterprise 2020 challenge and subsequently to the new initiatives providing solutions to new emerging needs of society.

Through the various initiatives and collaborations, the companies and organizations involved in the Enterprise 2020 initiative will produce tangible results and models which can be shared externally across industries.

Who Supports Enterprise 2020?

- ***Endorsed by all CSR Europe member companies and national partner organizations.***
- ***Promoted by 7 national governments*** *(Belgium, Denmark, France, Italy, Portugal, Spain, and Netherlands).*
- ***Political and financial support from the Belgian EU Presidency*** *(autumn 2010).*
- ***Financial support from the European Commission*** *through PROGRESS grant [2].*

Transforming markets - project example

A key challenge for economies and societies in Europe and globally is integrating environmental sustainability with economic growth and social welfare. From the business perspective, companies have to achieve energy and resource efficiencies in their production processes, reduce the environmental impact of their products throughout the entire product lifecycle, and contribute to a shift towards more sustainable consumption patterns [3].

As a step towards this direction American Microsoft and SAP, the world's largest inter-enterprise software company and the world's fourth-largest independent software supplier as corporate leaders working with stakeholder leaders: Imperial College, Johns Hopkins University, Tech America Europe and WWF on a project on enabling technologies for environmental sustainability. The project aims to develop a methodology that will help determine the optimal conditions to bring to market information and communication technologies (ICT) that will best enable a low carbon economy in Europe.

Inclusive societies

With regard to the "next generation" of employees, a network led by American IBM as a corporate leader working with stakeholder leader European Schoolnet explore the future skills needs of European industry and society with a focus on science teaching in schools.

Young people's interest in science is essential to the future prosperity and competitiveness of the European economy, but many universities report a reduction in the number of students choosing to enroll in scientific subjects. The Science in Schools program contributes to bridging this gap by fostering collaboration across companies on industry-developed science education resources and integration with government-led initiatives [3].

Science in Schools is intended as a long-term strategic program which aligns the interests of both industry and government in enhancing science teaching in schools and increasing the number of graduates entering careers in science and engineering [4].

Health and wellbeing

The project group, led by corporate leaders MSD (a global healthcare leader), Nestlé and Microsoft together with stakeholder leader the University of Maastricht, stresses that investing in a health-friendly work environment can help businesses increase employee wellbeing and productivity, thus reducing absences and lowering costs.

The common output of the Health Literacy program is to develop a “Blueprint for Business Action in Health Literacy” for CSR Europe membership and beyond, with a view to easing the implementation of Health Literacy programs for employees and other specific target audiences [4].

CSR Europe General Assembly event

CSR Europe hosted its annual General Assembly event on the 9th and 10th of June

2011 in Brussels. The theme of this year, "Value Creation as the new challenge for sustainable businesses in 2020 and beyond," provided the backdrop for CSR Europe to launch a new strategy and service offer for CSR Europe members.

Following outputs with the direct line to initiative Enterprise 2020 were made in the event:

- ***Enterprise 2020 initiative at the heart of CSR Europe strategy,***
- ***Launch of Enterprise 2020 Award (First award early 2013).***

Enterprise 2020 initiative at the heart of CSR Europe strategy

Through Enterprise 2020, ambition of CSR Europe is clear: to drive company action towards a smart, sustainable and inclusive Europe. **CSR Europe believes that there are two basic requirements for the ideal company towards Enterprise 2020 [5]:**

- ***Highly developed CSR Management and transparency***.
- ***Social innovation***.

On the Fig.1 we can see that a way how company can become the company in 2020 (enterprise 2020) it's required to have highly developed CSR management and transparency (management of total value chain towards increased business, environmental and social performance) at first and then to have social innovation as business strategy (= sustainability challenges drive the business strategy for enhanced P/L over mid- and long term).

Social innovation means new ideas, business models, products and services that resolve existing sustainability challenges.

Only by regarding such factors as: global trade and economic shift of power, poverty/education, urbanization and mobility, environmental degradation, resource scarcity (including water), demographic change/ageing, climate change/emissions, population growth and migration the company can be called enterprise in 2020.

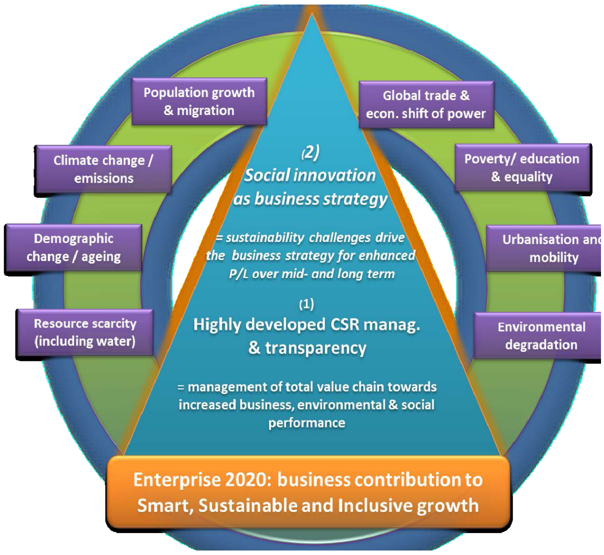

Fig. 1 Enterprise 2020 as the "ideal company" to support transition to a sustainable economy [6]

Other requirements [6]:

- ***Focus on mid- and long term business growth.***
- ***Complex partnerships & collaboration.***
- ***Capability to measure & manage.***
- ***Governance.***
- ***Integration in business planning.***
- ***Incentive.***

Enterprise 2020 Award

The main purpose of launching the Enterprise 2020 Award was to establish **bi-annual award** system to highlight remarkable contributions in tackling societal challenges.

The other ambition was to create a **milestone** event to take stock of progress and delivery.

The award is **not for companies** but for collaborative projects between different stakeholders [7].

Objectiveness will be assured by multistakeholder impartial jury.

Enterprise 2020 and China

"GoldenBee 2020" was launched at the Sixth International CSR Forum in Beijing in June 2011. "GoldenBee 2020" is inspired by and created in response to the "Enterprise 2020" launched by CSR Europe in October 2010.

Through “GoldenBee 2020”, a new platform is built up for Chinese companies to enhance the responsible competitiveness, share their experience, develop collaborative ventures and contribute to the global sustainable development [8].

At the launch, were identified ten key issues in CSR field, with which “GoldenBee 2020” is trying to lead CSR development in China for the next ten years, to support economic development transformation stated in the 12th Five-Year Plan, and to contribute to realize the goal of building a moderately prosperous society by 2020.

Enterprise 2020 in Spain

Forética, based in Spain, is a non profit multistakeholder organization working on promoting ethical and socially responsible policies.

On the 20th of September, Forética will host an international meeting in Madrid. The event will provide the backdrop for the launch of the Enterprise 2020 initiative in Spain. The initiative was inspired by CSR Europe’s own Enterprise 2020 initiative and is supported by both the European Commission and CSR Europe. Furthermore, the Spanish government has supported the strategy and Forética is taking the lead in spreading the Enterprise 2020 concept throughout the business network [9].

3. CONCLUSION

The paper refers to actual reactions to the document Enterprise 2020 such as examples pf projects in three categories: transforming markets, inclusive societies and health and wellbeing. It also points out the Enterprise 2020 initiative as the heart of the CSR Europe strategy and Enterprise 2020 Award.

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Enterprise 2020 – challenge for schools, universities and commercial practice IV.

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Abstract

The content of the paper concerns to critical and systematic analysis of current state of applied concept of sustainability of our planet Earth, a brief characteristics of document Enterprise 2020, analysis of actual reactions to the document and also our contribution to the challenge Enterprise 2020. This fourth – the last part of the fourth-part paper deals with our contribution to the initiative Enterprise 2020 by introduction of university subject "Sustainable corporate social responsibility" at our faculty.
This paper was supported by the Slovak Research and Development Agency under the contract No. LPP-0384-09: "Concept HCS model 3E vs. Concept Corporate Social Responsibility (CSR)." The paper is also a part of submitted KEGA project No. 037STU-4/2012 "Implementation of the subject "Corporate Social Responsibility Entrepreneurship" into the study programme Industrial management in the second degree at MTF STU Trnava".

Keywords: Enterprise 2020; Sustainable Development; Corporate Social Responsibility; Universities; Sustainable corporate social responsibility.

1. INTRODUCTION

Education to sustainable development should start at least at universities. Universities besides playing an important role in sustainable development (SD) and corporate social responsibility (CSR) propagation are the institutions where the future business leaders are educated.

The paper describes new subject we want to introduce on master level at our faculty. The project KEGA, including an introduction of subject called "Sustainable corporate social responsibility", will be specialized to prepare pedagogic and R&D employees of FMST SUT Trnava in the field of SD and CSR that will bring the improvement and extension of their theoretical knowledge and practical crafts that they can be applied and used in educational and R&D processes.

2. OUR BENEFIT TO INITIATIVE ENTERPRISE 2020

We try to introduce the new subject *"Sustainable corporate social responsibility"* within the study branch Industrial management on the master level at Institute of Industrial Engineering, Management and Quality of FMST SUT in Trnava. To reach the goal we gave in project KEGA in the third appeal called Content integration and diversification of academic study.

As it was mentioned before, the content of the project is to introduce the subject *"Sustainable corporate social responsibility"* to study branch Industrial management in context with European strategy of sustainable development, first time released in 2001 in Göteborg and thereafter revised in 2006 and 2009, with strategy Europe 2020 for employment and growth, with Enterprise 2020, with Conclusions of European Council from 19th November 2010 about education to sustainable development (2010/C 327/05), with UNO summit about Millennium development goals (20.- 22. September 2010) and currently accepted standard ISO 26000 of corporate social responsibility.

The major goal of the project is to introduce the subject *"Sustainable corporate social responsibility"* to study branch industrial management on the master level at the Faculty of

Materials Science and Technology of SUT in Trnava.

The partial goals of the project are:

- ***to process an analysis of available information resources of education to sustainable development and corporate social responsibility (CSR) topic,***
- ***to suggest curriculum of the subject "Sustainable corporate social responsibility",***
- ***to write teaching typescript for teaching the subject "Sustainable corporate social responsibility",***
- ***to verify the quality of teaching the subject "Sustainable corporate social responsibility" in experimental way,***
- ***to optimize the curriculum of the subject "Sustainable corporate social responsibility" and teaching typescript according the results of the analysis.***

2.1. The current state of the topic

Document Initial study of application of corporate social responsibility in Slovakia (2007) showed following suggestions for academic institutions: State universities should be the pioneers in the topic of CSR, they ought to rise up the consciousness and build up capacities to its implementation. Academic institutions ought to provide CSR courses at economy and management faculties at least. These institutions are responsible for preparing students who could perspectively perform prominent functions in commercial sector. As the future managers they should have enough practices with the implementation of formal CSR strategy [1].

In the world, that's permanently changing, every European citizen should be fitted with knowledge, practices and postures that help them understand and solve challenges and problems of everyday modern life, regarding environmental, social, cultural and economic impacts and take global responsibility. The recession totally devalued the years of economic and social progress and revealed structural deficiencies in European economy. Meanwhile the world is quickly moving and long-time problems as globalization [2], resource press and ageing population are getting deeper. It's important to have the strategy that could contribute to be strengthen from the recession and that could make the European Union economy intelligent and sustainable supporting the integration and high level of employment, productivity and social cohesion. Following documents should help to reach it: Europe 2020, Enterprise 2020, with Conclusions of European Council from 19th November 2010 about education to sustainable development (2010/C 327/05) [3], with UNO summit about Millennium development goals (20.-22. September 2010) [4] and currently accepted standard ISO 26000 of corporate social responsibility [5].

Project Enterprise 2020 is the unique platform for schools and universities that want to cooperate with companies and together make the research in the field of responsible management and develop ability of students and managers to be the future creators of sustainable values for companies and society.

Issuing from:

- ***holistic (systemic) approach to our planet Earth as an integral system,***
- ***knowing that objective reality that's rounding us has its own evolutional development which was negatively hit by human long-time acting,***
- ***confidence that the only alternative of humankind is the symbiosis of being in step with the nature and its regularities of development and sustainable development in all postindustrial expressions*** *(sustainable production, sustainable consumption, sustainable manpower, sustainable marketing, sustainable profit, sustainable quality of life,…),*
- ***especially from works and opinions of A. Blažej, F. Capra, T. M. Cook, D. C. Corten, F. Gregor, H. Handerson, K.Hatiar, J. Hyršlová, L. A. Ismagilova, J. Keller, M. J. Kiernan, V. K. Lozenko, P. Staněk , W. E. Stead a J. G. Stead, D. Zadražilová, J. Zelený, etc [6].***

we want to connect the present practices and knowledge gained by solving and successful vindication of research projects solved at IIMQ FMST SUT Trnava: grant scientific project No. 1/9099/02 VEGA "Environmentaly oriented management, marketing and logistics of strategic business unites"[7]; project APVV No. 019/2001: "Transforming Industry in Slovakia Through Partitipatory Ergonomic"; KEGA ME SR No. 3-3111-05: "Creation of virtual robotized laboratory for supporting teaching subject "Robots and manipulators" in new accredited studying program [8] and currently running project of the Slovak Research and Development

Agency (SRDA) under the contract No. LPP-0384-09: "Concept HCS model 3E vs. Concept Corporate Social Responsibility (CSR) No. LPP-0384-09" [9], by the project. Also the goal of SRDA project is, on the basis of critical systematic analysis of current state of creation and sharing the wealth of our planet Earth, to widen results of the projects and to contribute to filling the vision of Agenda 21 and Lisbon strategy in individual pillars of SD strategy in conditions of R&D activities and pedagogic process at our Alma mater FMST SUT Trnava. According to famous slogan: Think globally, act locally", our teaching typescript of "*Sustainable corporate social responsibility"* should help, which we think will contribute to the change of paradigm to creation and sharing the wealth on our planet Earth. It's because the current state in Slovakia, Europe and also in the world is unsustainable and there's a threat of expiration of mankind and of all living on our planet Earth [10].

2.2. Characteristics, description of the project

The project is contently oriented to thematic field No.3 :"Content integration and diversification of academic study." Content lay of the field: "Research oriented to preparation of structure and content of subjects specialized to basic business crafts within non-economic study programs of the 1.- 3. level of academic study."

Submitted project is specialized to introduction of the subject *"Sustainable corporate social responsibility"* to study branch Industrial management.

Presented project will prepare pedagogic and R&D employees of FMST SUT Trnava in the field of sustainable development and CSR that will bring the improvement and extension of their theoretical knowledge and practical crafts that they can apply and use in educational and R&D processes.

Expected benefits of the projects:

- ***Better graduates´ application on labor market and improvement of their employment, production and social cohesion.***
- ***Update and enhancement of teaching process at FMST SUT Trnava*** *in context with Strategy Europe 2020, Enterprise 2020, with Conclusions of European Council from 19th November 2010 about education to sustainable development (2010/C 327/05), with UNO summit about Millennium development goals (20.-22. September 2010) and currently accepted standard ISO 26000 of corporate social responsibility.*
- ***Increase students´ motivation.***
- ***Increase quality of pedagogy and R&D work of pedagogy and R&D employees at FMST SUT in Trnava.***
- ***Planned application of outputs of the project in social and economy practice.***

Graduates of newly created subject *"Sustainable corporate social responsibility"* will be the holders of ideas of sustainable development and CSR capable to transform the knowledge to practice of Slovak industrial companies and step by step they would affect the change of our managers and company shareholders paradigm.

The way of control and organizing assurance, the specific suggestion of process how to reach the project goals :

1. ***Preliminary phase of the research: January 2012 – August 2013***

- January 2012 – April 2012: to work up analysis of available information resources of the topic of education in SD and CSR.
- May 2012 – June 2012: to suggest curriculum of the subject *„Sustainable corporate social responsibility"* at FMST SUT in Trnava,
- June 2012 – July 2012: to suggest research project of empiric verification of suitability, effectiveness and quality of the subject *"Sustainable corporate social responsibility".*
- July 2012 – January 2013: to write first draft of educational typescript of *"Sustainable corporate social responsibility".*
- February 2013: to suggest questionnaires,
- March 2013 – July 2013: to correct the first draft of educational typescript of *"Sustainable corporate social responsibility"* on the basis of individual reviewers´ remarks.
- August 2013: to print educational typescript *"Sustainable corporate social responsibility*".

2. ***Realization phase of the research:: September 2013 – January 2014:***

- September 2013 – January 2014: experimentally to verify the suitability and the quality of the teaching process of the subject *"Sustainable corporate social responsibility".*

3. Valuation phase of the research: February 2014 – December 2014

- February 2014 – March 2014: to evaluate the experiment results (including the quality of educational typescript).
- April 2014 - May 2014: to write report of the research, on the basis of the results to optimize the curriculum of the subject *"Sustainable corporate social responsibility".*
- June 2014: to carry on workshop *"Sustainable corporate social responsibility".*
- July 2014 - December 2014: to present the outputs of the research in specialized and scientific journals and also on scientific events (workshops, conferences).

International cooperation with:

Moscow Energetic Institute (MEI-TU MOSKVA); UGATU UFA; ISEI UNC RAN UFA (RF)

Description of the cooperation – contract cooperation between:

- ***MEI - TU MOSCOW [11] a SUT Bratislava [12],***
- ***UGATU UFA [13, 14] a SUT Bratislava [15],***
- ***ISEI UNC RAN UFA [16, 17] a SUT Bratislava [18],***

within which we are making mutual exchange of relevant scientific and pedagogy information, we prepare issuance of joint monographs, papers to international conferences, exchange interships of doctoral students and teachers, memberships of scientific boards of journals and conferences.

Solutionist of the project is the leader: Prof. Ing. Peter Sakál CSc. and other solutionists are: Ing. Alexandra Arendášová, PhD., Doc. Ing. CSc. Miloš Čambál, Ing. Katarína Drieniková, Ing. Tomáš Naňo, Ing. Veronika Kaiserova, Mgr. Dagmar Cagáňová, PhD., Doc. Ing. Iveta Paulová, PhD. a Ing. Gabriela Hrdinová.

3. CONCLUSIONS

The paper refers to the importance of the introduction of the subject intent on education to sustainable development. Specifically we deal with the recently submitted project KEGA that's aim is introduce such a subject at FMST SUT Trnava called *"Sustainable corporate social responsibility".*

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Improvement business results through the implementation of the application business intelligence

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Abstract

Information today, although immaterial resources becomes one of the most strategically important resources for the company and its operations. For business owners and managers it is not enough to dispose of some information, they must to dispose of the right information, accurate and reliable information at a time when such information is required to make important strategic decisions in the company. Delayed information almost has no value, but timely, accurate and reliable information can significantly contribute to achieving positive business results in the company. So many managers and business owners today are aware of the importance of intangible resources, information, and often they ignore its value. However, in addition to the systematic and continuous collection of various types of information, as well as the success factors of enterprises, according to another very important factor in the success of the company, which is the systematic collection and data processing. In the enterprises data are collected to improve their business results, making timely and useful conclusions, which will direct the company in the right direction and which will to help Administration to define the strategy of the company. Business Intelligence is the systematic collection, processing and analysis in order to improve the competitive position of companies in the market, and improve the performance of a company. An effective way how the companies can reduce operating costs, which they have, to manage the human resources that they employ, to collect the necessary data that they can serve as a guiding principle for further appearance on the market, for the progress, for the increase the level of customer care, for the attitude toward competition and so on. That we can see that in the example of the company Blue Media Ltd. The company Blue Media Ltd. is a small company and relatively short-lived existence, realized significant competitive advantages, applications of Business Intelligence (BI) in its operations. The owner of the company Blue Media Ltd. has created an application Business Intelligence (BI), and its implementation are achieved substantial savings, not only in the operating costs, but also this application saving the time fot the owners and managers of enterprises. Time is an item which, as we all know, is not negligible, but in fact it is essential for owners and managers, as well as operating costs and human resources management. However, in addition to these savings so that valuable time is available to business owners and managers, and employees themselves, and the saving in various types of costs, the company Blue Media Ltd. intangible benefits achieved by applying Business Intelligence application such as: increased control of all employees, human resources are becoming more organized, with clear tasks, goals and a clear presentation of the results achieved in the sale, objectively evaluate the success of each individual employee, application Business Intelligence itself presents the conclusions of the employees and directors and gives them explicit instructions and tasks on a daily basis, the application BI defines the strategy of enterprise and enterprise performance in the market, the application BI offers a proposal for structuring the organization and the application BI is not subject to emotions and to mitigating circumstances of a particular employee in the company. Through the application of Business Intelligence in enterprises, and achieved a systematic review of human resources, better organization of the companies themselves, employees are becoming more organized, with clear tasks and goals ahead of them, and their own business owners and managers in this way, using BI in their business can be objectively evaluate the performance and success of each employee and reward their employees based on actual merit, assessed objectively.

Key words: An application Business Intelligence; Information; Data; Business results; Human resources.

1. INTRODUCTION

Information today, although immaterial resources becomes one of the most strategically important resources for the company and its operations. Information is an indispensable and irreplaceable resource of the organization which are constantly using and it can not spend, or reduced in value if it is forwarded to others. However, over time the information can become obsolete. A data is a set of characters that mean something, "processed information".(Lamza-Maronić, Glavaš, 2008, p. 11). For the business owners and managers it is no enough to dispose of some information, but they must to dispose of the right information, accurate and verified information at a time when such information is required to make important strategic decisions in the company. Delayed information is almost no value, but timely, accurate and reliable information can significantly contribute to achieving positive business results in the company. So many managers and business owners today are aware of the importance of intangible resources, information, and often ignores its value. However, in addition to the systematic and continuous collection of various types of information, as well as success factors for enterprises, according to another very important factor in the success of the company, which is the systematic collection and data processing, in order to improve business results, making timely and useful conclusions, which will direct the company in the right direction and that the Administration will help define the corporate strategy. Business Intelligence (BI) is the systematic collection, processing and analysis in order to improve the competitive position in the market, and improve the performance of an enterprise. Every business entity, governmental body or public institution, which supports some of its business with the information system can use business intelligence. Business intelligence is an upgrade of the information systems to support business. The information systems that support operations serve a continuously available transaction processing. A business intelligence system is a system that keeps information and knowledge about competitors, customers and suppliers. Business intelligence enables the business negotiation and numerically reasoned approach to customers and suppliers, operational quality planning, monitoring the behavior of competitors, the observation of individual market segments, and the prediction of some future occurrence. In today's uncertain times in which to place the business of small and medium enterprises, the source of data, timely obtain necessary information and data may affect of the status of a business entity in the market and ultimately its business success, and survival. Also, nowadays there are many definitions that explain the concept of business intelligence, and some of them are: A business intelligence represents a previously hidden knowledge that reveals itself from operational and business data routinely collected by applying the appropriate arithmetic-logical method, usually of supported information technology. (Panian, Klepac, 2003, p. 1). We can confirm that it is intelligence activities in the business world that are planned, organized and conducted by businesses, where the activity involves a legal process of collecting public and all available data with ethical funds, their analysis and conversion into finished business intelligence analysis ("knowledge") in support of the leadership of a business entity with the aim of adoption and implementation of the best business decision aimed at preserving the existing position of a business entity in a business environment, avoiding any threats, and ultimately the overall qualitative improvement of the business entity. (Lamza-Maronić, Glavaš, 2007).

2. BUSINESS INTELLIGENCE IN BLUE MEDIA COMPANY

The company Blue Media Ltd., the largest small business and the relatively short-lived existence, achieves significant advantages over the competition, run applications of Business Intelligence (BI) in its business. This company is a proof that sometimes for the success of the company size is not critical, but knowledge. Through IT enviable knowledge of the owner company Blue Media Ltd. created a Business Intelligence application that have greatly influences on the positive business success of the company. The key issues in contemporary business are as follows: What is the most important prerequisite of survival in today's turbulent markets? The answer is fairly simple -

information, or, more precisely, the information that you take appropriate action. It is equally true for all industries, economic sectors and industries, from agriculture, energy and mechanical engineering, to commerce and banking, and insurance and education (Panian, Klepac, 2003, p. 27.).

As can be seen from Figure 1 all employees of the company Blue Media reported to be in Application Business Intelligence (BI) through a code known only to them, and bring a variety of data that are useful to business owners and managers of the company, and it uses this data Management draws conclusions that are of crucial importance for the company. Use this information to the company going in the right direction.

In Figure 2 we can see what the employees the company Blue Media Ltd. all entries in the application. Employees enter into the application data on the corporate names of the top people with whom they held meetings for the sale of the company Blue Media Ltd. Furthermore, they enter data on company size, the number of products sold, the number of meetings and more. Finally, the application Business Intelligence itself ejects unwanted data, the company itself proposes solutions and conclusions. For example, the application itself throws with information about which companies are worth doing, in which the types of companies recorded the highest sales, which the employee has achieved the highest score, etc., which greatly helps the company Blue Media in making strategic decisions for the company, and a further appearance on the market.

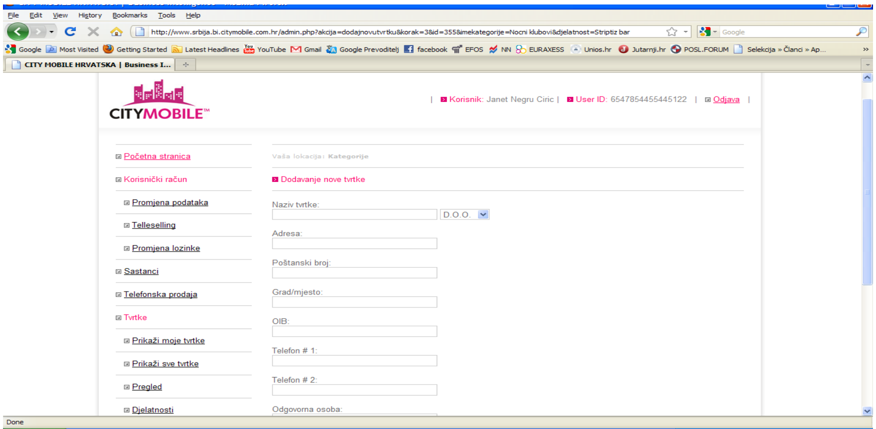

Fig. 1. The Business Intelligence Application

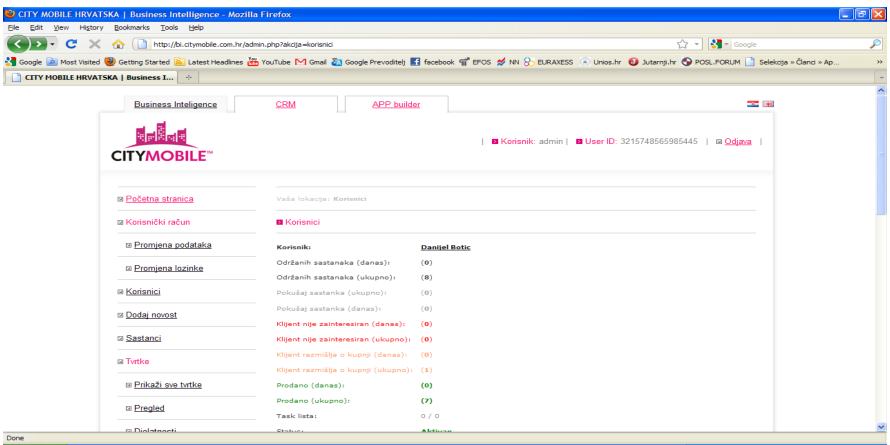

Fig. 2. The Business Intelligence Application

3. RESULTS OF THE BUSINESS INTELLIGENCE APPLICATIONS IN BLUE MEDIA COMPANY

The implementation of Business Intelligence applications to achieve significant savings in not only operating costs but also savings in time for the owners and managers of this company, and the time the item which, as we all know is not negligible, but on the contrary it is essential for owners and managers , as well as operating costs and human resources management.

Through the application of BI (Business Intelligence) in the company Blue Media Ltd., achieved savings in:

1. time available to business owners and managers of the company, and therefore employees
2. operating costs (cost of phone calls, meetings with staff costs and other expenses, application would propose an action plan, for example, travel)

However, in addition to these savings so that valuable time is available to business owners and managers, and employees and therefore savings in various types of costs, the company Blue Media Ltd. and intangible benefits achieved using the BI, and it is the following:

1. the company Blue Media increasing control of their employees
2. human resources are becoming organized, with clear tasks, goals and a clear presentation of the results achieved in sales
3. objectively evaluate the success of each individual employee (the modern system of business which are ambitious and successful protected and system minimally tolerate any attempt to avoid unreasonable tasks)
4. BI presents the conclusions of the employees and directors and gives them explicit instructions and tasks on a daily basis, taking into account the entire past history of operations on the basis of which the same conclusion and issued (this is to minimize errors in business)
5. increase productivity of enterprises and defining company strategy and market performance
6. BI offers a proposal to organize an organization (for example, the best staff in the team after the data analysis and conclusions on the X period of time proposed for the same team leader)
7. BI is not subject to emotions and mitigating circumstances of a particular employee in the business (for example, the emotions we mean hiring based on looks, but under extenuating circumstances, for example, single mother in need higher salaries, etc.)

Through the application of BI in enterprises, it provides a systematic review and human resources, better organization of the companies themselves, employees are becoming more organized, with clear tasks and goals to pursue, and own the businesses and managers in this way, the application would in its operation can be objectively evaluate the performance and success of each employee and reward their employees based on actual merit, assessed objectively.

4. CONCLUSION

Many managers and business owners today are aware of the importance of gathering information and control employees. Controlling is the functions and management subsystem which contributes to the efficiency and effectiveness in the work of management, increasing the ability of companies to adapt to internal and external changes, increases the vitality of the company and its market acceptability (Osmanagić Bedenik, 1998, p. 13). Information today, although immaterial resources becomes a crucial resource for the success of the company. The problems which are solved by applying the application Business Intelligence would have been the above-mentioned problems, such as lowering business costs and increasing profits, the owners and managers to use more time to perform routine operations, but also for strategic planning in the company. So, using this application, business owners and managers remains a lot more time at their disposal, which is absolutely necessary to the business running smoothly. It is important, however, stressed that the company's success is crucial to the ability of its owner to collected information on the needs of customers turned into knowledge that can be used to make good business decisions. (Goldstein, 2009, p. 53). Also, the implementation of BI applications enhances the control of employees, and it becomes a systematic, objective and commonplace, and the owners and managers can objectively evaluate the success of each individual employee, or by the results achieved.

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Qualificational and personal features of the manager

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Abstract

It is well known and confirmed by the practice that the company is such as is its leadership (management). Managers are thus the determinants of the prosperity of the company and one of the most important prerequisites of the good comapany management. Their role is very demanding as they decide not only for themselves and the company but they also decide whether the company will prosper and if the people working in the company will be working hard if the work will meet their expectations or at least fulfill their needs. They have a vital role in shaping the social environment, atmosphere and relationships inside and outside of the company. Their actions and behavior to the subordinates affect their attitudes, the job satisfaction and the performance. These are the reasons why I deal with the managers and their qualificational and personal features in this article. I examined the competences of the managers and I used the questionnaire method for this purpose.

Keywords: Manager; Competences; Skills; Activation Inteligence; Knowledge Inteligence; Emotional Inteligence.

1. INTRODUCTION

The contemporary managers are ever more exposed to high pressure of the surrounding created by quickly progressing and still changing external factors influencing the companies managed by them. In the light of lasting changes the reuirements on high level of managers are growing. It is necessary for them to be carefully prepared from the theoretical and practical point of view. Important is they are not only technically oriented but also have humanitary knowledge.

2. KEY COMPETENCES OF THE MANAGER

There exist various opinions of what predispositions the managers should have which faculties and abilities to have to successfully provide their managerial positions. Not only there exist many opinions of qualificative and personal features of the sucessful manager but there exist also many „designations“ of this issue. Some people speak about abilities, others about competences or predispositions and the qualificative profile, qualities, potential etc. There does not exist the unity or any generalization in this area. This is quite logical as it is not possible to difine any ideal combination of individual predispositions qualities or competences of the sucessful manager. Any unit and especially exact and exhaustive list of manager abilities that will be universal and valid for all the managers is impossible to create. Every company needs anything else, it has different imaginations, demands and expectations about its manager. It depends on the concrete company – of its conditions and situation inside and outside, its size, type, branch it is operating in, etc. and the concrete manager i.e. the level the manager is at, working position (specialization) and mostly of the individual personality. From this it results that particular company should be in suit with determined operative managerial position proper profile of abilities that is a hard task.

Despite of the above it is possible to determinate broader models of managerial competences that are different from competences of the other grous of employees [1]. In my PhD thesis I have examined what qualification profile, wich abilities, comptences should the sucessful manager have. It is important to say that this involves the key competences.

The concept key competences means essential, decisive and so economically perspective i.e. those that bring determined results. Generally they ensure to reach the required aim from economical point of view then achievement of benefit and prosperity [2]. The Slovak language lexicon defines the term key as that one that has basic denotation, decisive, the most significant [3].

I examined the key competences of the managers in three categories of the company: a micro company, a small company and a middle company.

My aim was to find out which competences are the most important to perform managerial work at required level and in which competences the examined managers have some reserves, weak spots. I used the questionnaire method. There were 20 competences in the questionnaire and the managers were asked to mark 10 of them and also put one number of the range 1 – 5 (1 – the less important competence, 2 – little important, 3 – important, 4 – very important, 5 – especially important competence). With regard to reserves, weak spots, in this case the managers had to mark 10 competences of 20 mentioned and to the pertinent 10 competences state one number of the range 1 – 5 (1 – the smallest reserve, 2 – small, 3 – middle, 4 – large, 5 - the laregest reserve).

Based on the examination results I present competency models of managers in micro, small and middle companies identified by the examined managers. It contains the order of the individual competences – Fig. 1, 2 and 3. It concerns the primary competences of the managers to perform their work at the required level.

The primary competences of managers in micro companies

Communication skills
Team work
Stress management
Ability to solve problems, conflicts
Flexibility, adaptability, proactivity
Leaderahip
Time management
Assertiveness
Change management and achievment
Digital literacy

Fig. 1. The primary competences of the managers in micro companies

The primary competences of the managers in small companies

Communication skills
Ability to solve problems, conflicts
Flxibility, adaptability, proactivity
Leadership
Team work
Time management
Proficiency in foreign language
Stress management
Creativity
Enterpreneurship

Fig. 2. The primary competences of the managers in small companies

The primary competences of the managers in middle companies

Communication skills
Team work
Flexibility, adaptability, proactivity
Leadership
Ability to solve problems, conflicts
Time management
Creativity
Stress management
Proficiency in foreign language
Change management and achievement

Fig. 3. The primary competences of the managers in middle companies

The stated models of the key competences of the managers in the examined categories of companies could be considered to be the general groups of characteristics of the sucessful manager of the 21st century. It could be emphasized the above models of competences are not unreachable. The individual competences can be built and shaped.

The specific business should use the mentioned systems of competences as the inspiration. It is needed to adapt them to finish their forming that means to be in suit with the specific requirements. Each of the competences should be replenished by the demonstration of concrete activity that is required from the manager involving required level. As much the group of the managers for which the competency model is prepared is general as smaller is the efficiency of this model. My aim was not to create the universal competency models for examined companies but only for certain sets or lists of competences that need to be fit to the specific job position in specific company. This involves the basement that pics out the meaning of what makes the manager the sucessful manager. It is important to note also the fact that managing the company under the present conditions is the uncertainty management, the management in conditions characterized by a high degree of variability.

Each manager should be prepared for this therefore it is needed to get prepared not only for changing requirements of the current work but also to cope with the possible future requirements of the work.

Besides finding out the competences that are important for the managerial job at required level I was finding out in the examination in which comptences the managers have reserves (weak spots) as the potential of possible improvement. To the individual competences the examined managers had to assign some importance based on my range.

The order of 10 competences from the managers of micro companies reserves point of view is following: proficiency in foreign language, leadership, time management, ability to solve problems, conflicts, communication skills, team work, stress management, orientation on improvement, enterpreneurship, change management and achievement, knowledge management.

The order of competences from the weak spots point of view where the managers of small companies have reserves is following: proficiency in foreign laguage, time management, leadership, enterpreneurship, change management and achievement, communication skills, stress management, basic knowledge of economics, law and finance, ability to solve problems, conflicts, assertiveness.

The managers in the middle companies have reserves in following cmpetences (reported in the order – from competences with the biggest reserves to competences with the smallest reserves): proficiency in foreign language, leadership, change management and achievement, time management, ability to solve problems, conflicts, enterpreneurship, communication skills, emitional inteligence, assertiveness.

From the weak spots point of view the competences are the potential possibility of improvement for the managers. These are the areas where the managers can improve and which they can form.

3. CONCLUSION

The competences are regarding the whole human personality gained throughout the whole life in the same way they are improved and lost [4]. There exists no unique consisteny in managerial work which competences the managers have to have to do their work on the required level. It could be considered from different points of view and based on various criteria. There also does not exist exact specification of who could bcome a manager or what kind of education he needs. There are many great managers in the practice without formal managerial education but also many of those that did not succeed even they were graduates of the most prestigious universities or education instutions.

Being a leader worker is not the mission but the profession that can be learned just like the others. However according to my opinion not anyone can be the manager. Everyone has different talent, different predispositions. Each of us got something else in the birthright and not all of us are universal i.e. destined for any profession. There are various examples of sucessful managers some of which have genetic talent, some have luck, others education or there are those who have to hard-earn it. Some kind of driving power and also some genetic feature and inherited characteristics are important.

Simplified it is possible to say that predispositions for managerial position are regarding the whole manager's personality i.e. his/her professional and personal feature. The competences that managers need for their work can be learened at some level alternatively they can be improved. Some of them are more sucessful, others less. It depends of specific personality of the manager.

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Survey on Routing Algorithms

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Abstract

People use computers and network capable devices in more and more aspects of their life, which results in an exponentially growth of the network traffic. Therefore there is an increasing demand on efficient routing algorithms.
An ideal routing algorithm should be quick and should take into consideration several essential aspects including technical and economical ones as well. In this paper, we do a survey on some traditional (e.g. Bellman-Ford, Dijkstra, etc.) approaches and some computational intelligence based (e.g. Fuzzy Routing, Vague Set Theory based Routing) ones, which are also able to incorporate knowledge gained from human experts.

Keywords: Routing algorithms; Computer network; Fuzzy logic; Vague set.

1. INTRODUCTION

The task of traffic management or routing is to design a way (route) through which the network traffic will pass. In packet-switched computer networks routing manages the transport of packages with logical addressing from the source towards the destination, through network nodes. Routing is based on a routing table, which is in the router's internal memory, and contains the details on the possible paths targeting different destination networks.

The routers update the stored information by communicating with other routers regularly,. So they can design the optimal route from the source to the destination at all times. The mode of this communication is defined by the applied routing protocol. Each router knows its neighbor routers and the networks attached to them. The router shares this information first with its direct neighbors and through them with the whole network. Thus the routers build the network graph. Routing protocols are used to create and regularly update the routing tables.

In this paper, we do a survey on five significant routing algorithms that represent both the fields of traditional approaches and computational intelligence based approaches. After describing their key ideas and characteristics we present their advantages and disadvantages as well.

2. BACKGROUNDS

The topology of the network can be described by a graph, whose the nodes are routers and whose edges are links. The main task of the routing is defining the path of the package in this graph. There can be several possible pathways from the source to the destination. To find the best, one may consider the length of the way (how many links it leads through), the delay, the reliability (package loss), the band width, the cost, the load of the pathway, and the telecommunication rules or policies.

According to these aspects the applied routing algorithm will designate the optimal route. It is possible and often necessary to distribute the traffic between two or more paths. Thus one does not prefer one or another, but uses both of them in some proportion (load balancing).

The routing table contains the IP address of the destination network, the subnet mask of the destination network, the next hop, the route type, the routing protocol, the distance (metric), the route age, and the default route, where the routers forward the package if they do not find the destination network in their routing table.

The basic functions of the routers are the followings.

- The router receives the package arriving through the input interface.
- The router matches the destination address of the package to the rows of the routing table.
- If there are more matching rows the router chooses the one with the longest identical prefix.
- If there is no matching row the destination is not available and the package cannot be forwarded. Therefore the router drops the package and sends an ICMP error notification to the sender.
- If there is a matching row the router forwards the package through the correct output interface to the neighbor given as the next hop or to the destination target if there is no other hop.

The main steps of the IP address matching are the followings.

- The router organizes the rows of the routing table in descending order by the height of the subnet mask.
- If there is no *matching* row in the routing table (N=0), the search ends.
- If there is a matching row (N=1), the router applies logical AND operation on the whole bit sequence between the target IP address and the network address of the Nth row.
- If the result of the logical AND operation is equal to the value of the Nth row destination subnet mask, then the address matches the N. row, and the algorithm ends.
- Else $N=N+1$, and continue the algorithm on point 2. Thus it ensures that if there are two or more matching rows, the one with the longest prefix (same as the destination addresses') will be chosen.

3. ROUTING ALGORITHMS

Most routing protocols fall into one of the following two classes: *distance vector* or *link state*. In this section we review shortly the basic concepts of five routing algorithms. The first three of them apply traditional approaches while the last two introduce new ideas and tools from the field of computational intelligence.

3.1. Distance vector (DV) algotithms

Distance vector (DV) algorithms are based on the work of R. E. Bellman, L. R. Ford, and D. R. Fulkerson and for this reason occasionally are referred to as *Bellman-Ford* or *Ford-Fulkerson* algorithms [4].

According to these protocols the routers communicate only with the neighboring routers. Each router reports to all of its neighbors in an advertisement how expensive paths it knows to a given destination. They only change information about the costs. The path to the destination (which nodes it leads through) is unknown. After collecting these advertisements the router chooses the cheapest way, and forwards the package to the neighbor proposing it. Then it reports this route to the other neighbors adding its own costs to it.

The advantage of this approach is its simplicity and easy implementability. The disadvantage of this method is that "routing loops" can evolve and it does not take into consideration other aspects. Examples of distance-vector routing protocols include RIPv1, RIPv2, IGRP.

3.2. Link state protocol

The link state protocol is based on Dijkstra's algorithm [4]. According to this protocol the routers first map the whole network to a graph. Then they look for the shortest route to the destination in this graph. The routers change information about the state of their own interfaces with every router in the network. A link state advertisement contains the identification of the node producing it, the identification of the nodes connected to the producer, and a sequence number. So all the nodes can individually construct and frequently refresh their own topological graph.

The advantages of this approach are that it usually finds the optimal route, it is adaptive and responsible. When a router latches on to the network, the other routers quickly detect it. But when a router disconnects from the network, this information spreads not so rapidly. Other disadvantages are that it generates large data traffic and that calculating the optimal route needs time.

3.3. Open Shortest Path First (OSPF)

The OSPF [4] protocol can be an alternative for the RIP standard. There is a host that gets to know all the changes happening in the network, and immediately passes on the information to all other hosts. While the RIP sends out the whole routing table in every 30 seconds, OSPF forwards only the actual changes, when they happen. Routers using OSPF usually contain a built in RIP support.

The advantage of this protocol is that it generates less data traffic then the distance vector protocol or the link state protocol. When a router detects a network error, immediately forwards the information to the other routers. The disadvantage of it is that calculating the routs requires a strong CPU and time.

3.4. Vague Set Theory based Routing (VSTR)

Ali proposed in [1] a routing algorithm that applies the theory of vague sets. Vague sets [2] can be seen as an extension of the classic fuzzy set concept by expressing the vagueness in the available information in form of two membership functions. The first one is called truth membership function and expresses the lower bound of the grade of membership originated from evidence that supports the assumption. The second one is called the false membership function and arises from the evidence against the membership.

VSTR basically does a distance vector based routing based on one parameter, i.e. the estimated delay to reach other routers. Its key idea is that instead of creating a vector with crisp numbers expressing the delay values to reach other routers in the network VSTR builds a vector in which the individual delay values are expressed by the means of vague sets. After each data transfer a routing table is build on the receiver router side based on the vague sets which finally will be transformed into crisp vales.

The advantage of this approach is that allows expressing the inherent vagueness in the estimation of the delay times in a formalized way. Although the paper suggests the application in case of a special parameter (delay) it easily can be used in case of other frequently applied parameter types as well.

One could mention three main drawbacks of VSTR. Firstly, it increases the computational complexity of the routing process. Secondly, the description of the method is far too general, i.e. it is not specified how the vague delay times are estimated. Thirdly, although the paper claims the decrease of the network traffic as a result of the VSTR's application it is not entirely clear how and why that should happen.

3.5. Fuzzy Shortest Path First Routing (FSPFR)

Fuzzy logic is a very successful member of the family of soft computing techniques with a wide area of applications (e.g. [5]). Arnold et al. proposed in [3] a fuzzy version of the Shortest Path First Routing [4] algorithm. The key idea of FSPFR is that it replaces the classical link evaluation function by a fuzzy evaluation module and contrary to the most known shortest path strategies it uses not only one, but eight parameters as routing information, which are organized in three groups.

The first group representing the cost performance relation contains the link (data transfer) capacity, transmission cost, and the transmission time. The second one describes the delay situation on the link and contains the transmission delay (transmission time + processing time + queueing time) and the change of transmission delay. The parameters of the third group characterize the trust in the link. Here belong the link security (reliability), the node security (reliability), and the packet security (the packet does not get lost in overload situations).

The algorithm evaluates each link by the means of a crisp number called quality number, which is a result of a fuzzy inference based on the eight initial parameters. FSPFR first aggregates the parameter values in each group in intermediate linguistic variables using fuzzy inference and three separate rule bases. The resulting variables are the performance, the time, and the security. Next, a second inference step is involved to determine the fuzzy weight of the link. The final crisp evaluation value of the link is determined by calculating the reciprocal value of the fuzzy weight's defuzzified value. The rest of the routing procedure is identical with the classic SPFR.

The advantages of FSPFR are that the design and tuning is straightforward for a human expert in networking. Owing to the knowledge stored in form of fuzzy rules one can define, modify, and interpret the difference between the importances of the parameters taken into consideration, i.e. complex routing strategies can be formulated.

The disadvantage of FSPFR is that it increases the computational complexity of the routing, which could have a negative effect on the speed performance.

4. CONCLUSIONS

Routing in computer networks is a complex task with many aspects to be taken into consideration and which needs sophisticated solutions. In this paper we examined briefly five approaches by presenting their key ideas, advantages, and disadvantages. There are simple and complex solutions that also can incorporate human experience applying fuzzy or vague set based approaches.

The simple solutions usually easily can ensure a quick decision; however, often this can be only a suboptimal solution because they do not take into consideration all the important factors. In contrast to them the newer solutions calculate with several aspects.

5. ACKNOWLEDGEMENTS

This research was partly supported by the National Scientific Research Fund Grant OTKA 77809.

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Statistical Implicative Analysis, a means for multidisciplinary investigation

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Abstract

Statistical Implicative Analysis is mainly used by didacticians as a profitable and heuristic method of data analysis. In this paper we show how S.I.A. can be used and what special research results it can provide on example of students' knowledge of differential and integral calculus, as well as of basic resolution methods of differential equations at the end of the first year of Bachelor's degree.

Keywords: Statistical implicative analysis; Similarity diagram; Hierarchical tree; Calculus; Differential equations.

1. INTRODUCTION

Statistical implicative analysis is a data analysis method created by Régis Gras, which has a significant impact on a variety of areas ranging from pedagogical and psychological research to data mining [1].

The generic problems at the origin of the development of the Statistical Implicative Analysis were the evaluation and the structuration of such implicative relationships between didactic situations [2].

The implicative statistical analysis aims at giving a statistical meaning to expressions like: „if we observe the variable *a* in a subject of a set E, then in general we observe the variable *b* in the same subject" [3].

C.H.I.C. is a software tool that allows implementation of Statistical Implicative Analysis by offering an effective interface for easy use.

Software C.H.I.C. (Cohesitive and Hierarchical Implicative Classification) allows different treatments:

- the building of a hierarchy of similarities according to IC Lerman's method;
- the building of the implicative graph of variables and of the implicative tree of classes;
- the designation of subjects who contribute the most to the paths of the graph or to the classes of the tree;
- the comparison between the implicative graph and an inclusive graph, which modelizes at the best the inclusion of classes of subjects to a given threshold [4].

The most classical tree is a similarity tree that it is based on the similarity index defined by Lerman [5]. The implication intensity can be used to build an oriented hierarchy tree or to define an implication graph. The construction of the hierarchical tree is based on the following process: Two of the variables that are the most similar to each other with respect to the similarity indices of the method are joined together in a group at the highest similarity level. This group may be linked with one variable in a lower similarity level or two other variables that are combined together and establish another group at a lower lever. This grouping process goes until the similarity or the cohesion between the variables or the groups of variables gets very weak [6].

2. METHOD

Data were collected from 80 students attending the first year of Bachelor's degree at the Faculty of Materials Science and Technology of the Slovak University of Technology.

A test was consisted of six tasks. Interrogate students followed the lessons of Mathematics II. This calculus course is compulsory for all the study programmes at the faculty. The objective of the course is to provide an understanding of definite integrals, differential calculus of functions of several variables and basic resolution methods of differential equations. Below we give a brief description of the test and the corresponding codification of the variables used for the analysis of the data.

The first task concerned the geometric application of the definite integral. Students were asked to find the area of the region enclosed by simply curves. The correct solution was coded as CS1. A partial solution was coded as PS1, so the answer is partially correct if the graph is correctly represented and the definite integrate is written correctly. A wrong answer or any solution was coded as NS1.

At the second task students had to find the partial derivatives of two functions of two variables. In first function our intention was to test students' knowledge in the quotient differentiation rule. In the second function we examined the students' difficulties with the derivative of a composite function. The variables that were used were CS2A (correct answer for first function), CS2B (correct answer for second function), PS2A, PS2B for the partial answer correct (one partial derivative is correctly found, with respect to x or with respect to y) and NS2A, NS2B (wrong answer or not solution).

At the third task students had to determine local extrema of a function of two variables. Finding all critical points is considered as partial solution correct. The codification of this task is the same CS3, PS3 and NS3.

At the fourth task students were asked to solve a separable first order differential equation. Specially, the students had to find the particular solution, using the initial condition given. The variables were CS4, PS4 (partial solution is correct if the students separated the variables correctly) and NS4.

At the fifth task students had to solve a first order linear differential equation. The codification for this task was CS5, PS5 and NS5. Partial solution of this task is correct if the integrating factor is found correctly.

Finally the sixth task was a sixth order linear differential equation. For this task, the codification was the same CS6, PS6 (partial solution is correct if all the roots of auxiliary equation are found) and NS6.

All the variables are binaries, so with value 1 if it is manifested for a student and with value 0 in the contrary case. So we obtain a matrix presence-absence of dimension $n \times m$ where n is the number of the subjects (here $n = 80$) and m is the number of the variables binaries.

For the analysis of the collected data, the similarity and implicative statistical methods were carried out using computer software called C.H.I.C, version 4.2 [7]. A similarity diagram and a hierarchical tree were produced. The similarity diagram allows for the arrangement of students' answers to the tasks into groups according to their homogeneity. The hierarchical tree, based on the implication intensity, shows significant implicative relations that indicate whether success on a specific task implies success on another task related to the former one.

3. RESULTS

The results of this study are organised into two parts based on the method of analysis. Figure 1 illustrates the similarity diagram of students' responses to the tasks of the test. Four clusters of tasks are identified in the similarity diagram. The first cluster involves the correct answer to the first, third, fourth and fifth task that represents students' efficiency in solving the first order differential equations and in integral questions. Particularly, there is statistically significant similarity at level 87 % between the variables (CS3 – CS5, CS4) and at level 90 % between the variables (PS3 – PS6) in the first Cluster that demonstrates students' abilities to solve algebraic equations. The second cluster is in the same context that the first cluster of tasks. The strongest similarity at level 91 % occurs between variables (PS1- PS5), which involve partial solution to the integral task and finding the integrating factor of the first order linear differential equation with students' inabilities to separate the variables of separable differential equation. On the contrary, the third cluster involves the correct answers for a partial differentiation task and any solution to the integral task and any or partial solution to a first order differential equation. This three clusters shows that some problems became more difficult for some students, while for the other students the same problem became easier. The total similarity of this third cluster, represented by the red line, is statistically significant. The fourth cluster is consisted of any or partial solutions to the tasks of partial differentiation with the correct solution to a fifth order linear differential equation. Specially, we can observe statistically important similarity at level 99 % between the variables (NS2A – NS2B) that suggests the close connection between the answers unsuccessful for the partial derivatives of a composite function and the basic rules of partial differentiation.

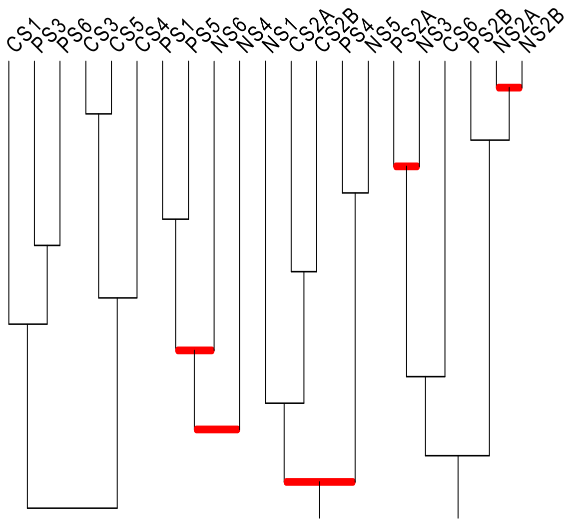

Fig. 1. Similarity diagram

The hierarchical tree in Figure 2 shows significant implicative relations between the variables. Six groups of implicative relations are identified. The implications represented by red lines represent relations significant. The first group of implicative relations suggests that success in the first task implies success in the fourth task; also in the second group an incorrect solution or any solution for the second task implies an incorrect solution for the third task. Students, who are unable to find the partial derivatives, couldn't find the local extrema for functions of two variables. In regard to the third question, the third group of hierarchical tree refers to implicative relations who connect partial solution for the third task with correct solutions for the second task (PS3 → (CS2B→ CS2A)). In this group a very strong cohesion at level 97 % appear between the second tasks of the test, that had also the bigger rates of success, occurrence of 55 for the variable CS2B and 56 for variable CS2A. This indicates that student who can find the partial derivatives of the composite function, use the quotient differentiation rule correctly. The implication relation of the third and the fifth group agrees with the findings emerged from the similarity diagram. Finally most powerful cohesion at level 98 % in the fourth group is presented between correct answer for the fifth and third task. Students' great difficulty in the fifth task is shown by their low success rate (12 %).

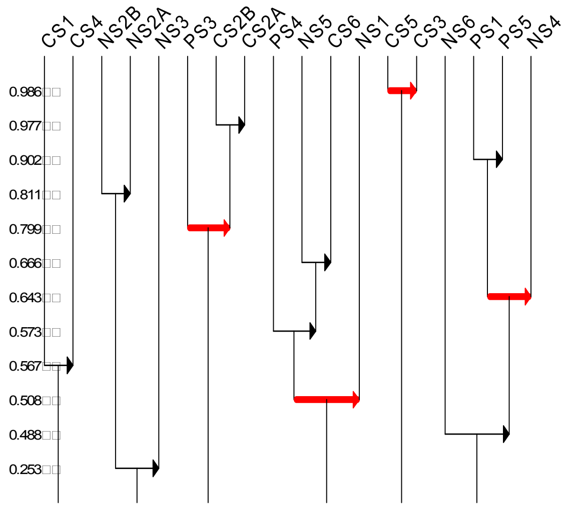

Fig. 2. Hierarchical tree

4. CONCLUSION

In this study, a specialized software C.H.I.C. is used for simple, multiple correspondence analysis and hierarchical clustering of student's understanding of integral calculus, differential calculus of functions of two variables and basic resolution methods of differentials equations at the end of a compulsory calculus course at first year of Bachelor's degree.

The lowest success rate of the first and fifth task, show the students' difficulties in resolution a first order linear differential equation, as well as in geometric application of the definite integral. We also observed the students' inabilities to draw the graph of simply curves manually. We suggest that results from the utilization of the mathematical software Winplot to represent the graphs on the lessons of calculus course.

The difficulty for using the quotient differentiation rule or finding the partial derivatives of a composite function is less. In the group “easy” question we can find differential calculus. These tasks have the biggest rates of success.

The close similarity relation between students’ correct solutions for the differential calculus tasks and incorrect solution or any solution for a differential equations or integral calculus indicates that students were more likely to find the partial derivatives of functions of two variables rather than solve a differential equation. This result shows the students unfamiliarity with solving differential equations. Referring to diagrams of our analysis, students who provided a correct solution in integral calculus and solved the differential equations, succeeded at the other tasks of the test.

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Lifelong learning in Republic of Croatia

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Abstract

Five years ago Croatian Government adopted a strategy of adult education, action plans for its implementation and its first Adult Education Law and established the Agency for Adult Education, which resulted in significant improvements in the development of these activities and education of the population.

The paper analyses the situation of adult education in Croatia - information on participation, service providers, content, teachers and funding of adult education. Data of the Central Bureau of Statistics, the Croatian Employment Service, EduCenter, Eurostat and the Data Base of the Agency for vocational and adult education whereas used in this study.

Eurostat study Adult Education Survey, which is being made in Croatia by the Central Bureau of Statistics, covers a sample of 5000 respondents aged 25-64. Labour Force Survey (LFS) is conducted quarterly, on the sample of about 5 600 housing units and at an annual sample of more than 40 000 respondents in the Republic of Croatia.

In this paper, terminology was used in accordance with the Adult Education Law. In cases where the original documents, from which the data were adopted, used different terminology, the terms of the original text were used.

Keywords: Adult education, lifelong learning, adult education funding, facilities and teachers in adult education.

1. EDUCATIONAL STRUCTURE OF WORKING AGE POPULATION

One of the main indicators of the educational system is the educational structure of the working age population. In the context of adult education are very important data on people with little or no formal education, because the task is precisely this part of the education system to enable these people to subsequently acquire the knowledge and skills that are acquired in the regular education process.

Data on changes in the educational structure of the population that is taking place over time are important because they allow to identify trends, predict what the situation will be in the future and thus represent one of the basis for defining development priorities in the segment of the education system, including the adult education system.

1.1. Employees

The largest part of the employee population, more than 60%, have completed some high school. In doing so, prevalent were people who completed three or four schools for a variety of occupations. A further 21% of people completed at least a college or professional study. This means that four fifths of all employees received more education than compulsory school education.

However, 3.3% of employees have not finished primary school, which is even higher than the number of those with only grammar school.

Table 1. *Educational structure of employees from 2006 till 2009 [1].*

	2006	2007	2008	2009
No school and partial elementary school	3,9	3,2	3,5	3,3
Elementary School	15,1	14,8	14,7	14,4
High school that lasts for 3 years and schools for skilled workers	32,5	32,7	32,7	31,7
High school for 4 years or longer	26	26,7	26,6	26,7
Grammar school	3,4	3,5	3,1	3
College and graduate studies	6,9	7,3	7,2	7,3
Faculty, academy, MSc, Ph.D.	12,2	11,8	12,2	13,6

It is evident that the four-year period saw an increase in the share of persons with higher education levels, and reduction of the proportion of those with lower levels of education. Do the biggest changes in the structure of employment occurred in the highest category of educated people, and the percentage of faculties, doctorate and master's degrees since 2006 until 2009 increased by 1.4%.

Given that the share of educated and highly educated at the expense of increasing the proportion of those with little or no education, the role of adult education to increase personal employability is increased.

1.2 Unemployed

Although people with secondary school education are prevalent in the group of unemployed people (62%), there is a significant number of people with only primary school, while the number of people who have finished professional studies and higher education, as well as people who have finished college, academy, master's or doctorate is considerably smaller and together makes just over 8% of all unemployed.

Table 2. *The educational structure of unemployed 2006-2009*

No school and partial elementary school	6.02%
Elementary School	23.71%
High school that lasts 3 years and schools for skilled workers	34.59%
High school that lasts 4 years or longer and grammar school	27.39%
College and graduate studies	3.70%
Faculty, academy, MSc, Ph.D.	4.59%

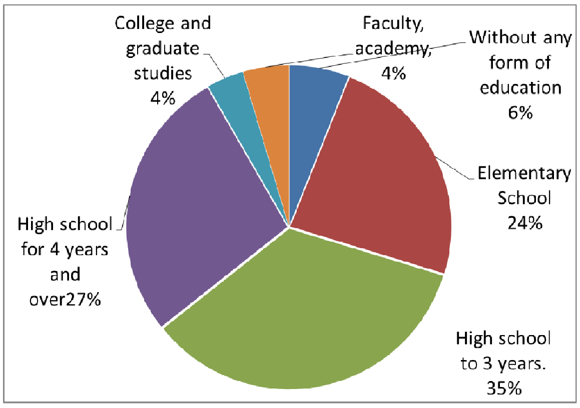

Fig.1. *The educational structure of unemployed since 2006 until 2009 [2].*

1.3. Employers' needs for additional education of workers

The views of employers on the need for additional education of workers are an important indicator of the required knowledge, skills and competencies and thus one of the main factors of adult education aimed at meeting the needs of the labour market. These data also indicate the willingness of employers to encourage further education and training of their employees, as well as financing their training.

The study of attitudes of employers shows that only 22.7% of them have a need for additional education of existing employees, while the vast majority (77.3%) of these do not.

Table 3. *Attitudes of employers on the need for additional training of employees by type of knowledge and skills [3].*

To what extent:	Greater	Biggest	Minor
Micro-professional and technical skills	61%	26%	39%
Computer skills	47%	19%	53%
Knowledge of foreign languages	51%	17%	49%
Skills dealing with clients	60%	17%	40%
Skills of team work and communication	60%	18%	40%
Other	59%	4%	41%

The largest number of employers (26%) believes that the greatest educational need is related to the sub-professional and technical knowledge, and to a greater extent (61%). Although computer skills are in the second place, and 19% of employers have expressed the need for additional education of workers in this area, most of them believe that it is a lesser need.

Other areas that many employers singled out as the one for which there is a need for additional education are language skills, skills in dealing with clients and team work and communication.

2. PARTICIPATION IN ADULT EDUCATION AND LIFELONG LEARNING

In recent years much research was carried out in Croatia and in other European countries with the aim to determine the share of adult population participating in some activities of learning, education and training. LFS (Labour Force survey) which was carried out by the Central Bureau of Statistics found a figure of 2.3% of adults participating in lifelong learning, where the reference period was 4 weeks preceding the survey.

In these studies it was found out that the lifelong learning involved 2.3% of the adult population. Total number of students of formal adult education programs was 18,187, the average age of participants was 30 years, and the share of unemployed in the total number of students of formal adult education program is 33%, while the share of the adult population that has no desire to participate in adult education is 73%.

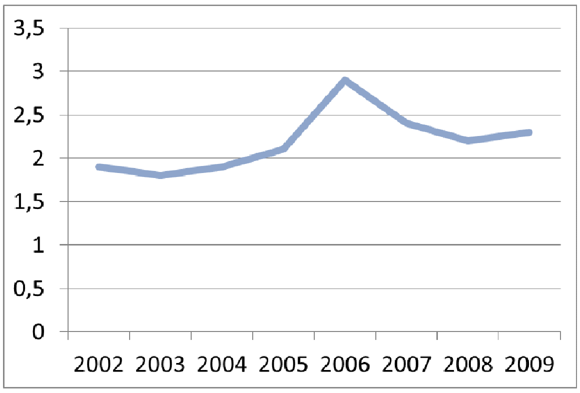

Fig. 2*: Rates of lifelong learning in Croatia - adult participation in education and training [4].*

Given that this research is conducted across Europe, the results allow comparison of the situation in terms of lifelong learning in Croatia with those in other countries. It is obvious that Croatia is on the field at the very bottom, at the same place as the United States, and that the countries included in this review have a lower rate of participation in lifelong learning only in Bulgaria and Romania. Croatian score is four times lower than the EU average (9.3%), and the difference is even greater if you look at the results of the states where the proportion of adults participating in lifelong learning is high, such as Denmark (31.6%), Iceland (25.1%) and Switzerland (24%).

The rate of adult participation in all activities of education and training amounts to 21.2% 4.5% of which is formal education and training and the rest is non-formal education and training (18.4%).

Although these data show that 21.2% of adults, who participated in a learning activity, provide a brighter picture than the one from the Labour Force Survey, Croatia still has one of the lowest rates of adult participation in education and training in Europe. European average within this approach amounts to 36.1%, out of 25 countries that participated in this survey, Croatia is at the 23.place.

Participation rate was slightly higher among men (21.4%) than women (21.1%). Review of data by age groups shows that the highest participation rate is in the category of the youngest adults, 25-34 years, which is up to 33.5%.

Adults who belong to the age group of 35-54 years participate less in education and training, one out of five people (20.2%). The lowest proportion of people who participate in the activities of education and training is present in the age group of 55-64 years, where it accounts for just one in ten people (9%).

Although participation in adult education across all age categories is below average in the EU countries, the smallest difference is in the category of persons from 25-34 years, where we had 33.5% of persons in relation to the European average of 45.4%. The biggest difference is present in the category of persons older than 55 years, where the Croatian score (9%) was significantly lower than the European average (21.8%).

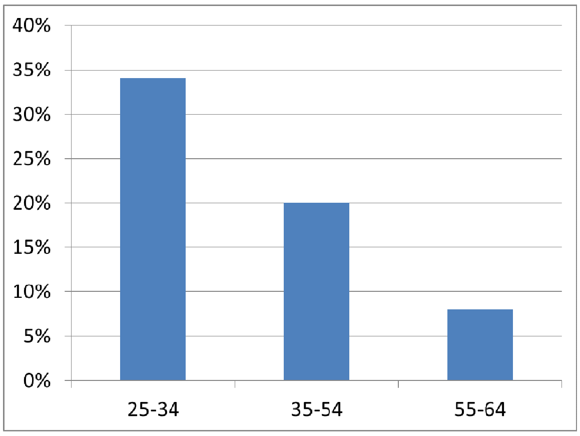

Fig.3. *Participation in adult education and training activities by age [5].*

Participation is expected by most people who have university or higher education, and 54.9% of highly educated people participate in the activities of education and training. On the other hand, the least involved people with the least education - only 3.9% of persons without a high school. This figure refers to a known problem that those who have the most formal education learn after the regular educational process, and those whose formal education was very low are a lot less involved in some form of adult education.

In comparison to the other European countries, Croatia deviates in the category of people with the least education, and only 3.9% of people who have no high school participate in educational activities, while the European average is 18.1%, a lower result than the Croatian has only Hungary, 2.6%. As the level of education rises, the difference between the situation in Croatia and other European countries is decreasing, so the category of the population with the highest education in Croatia with the rate of participation of 54.9% is slightly below the European average of 58.8%.

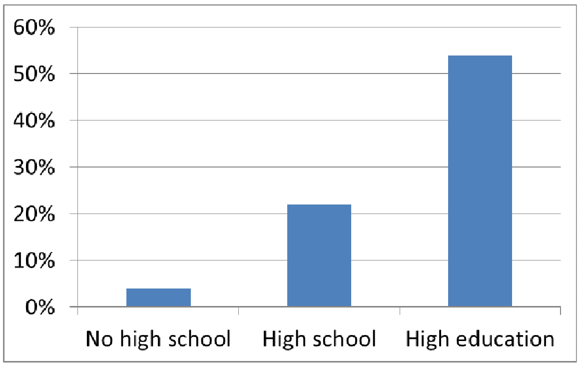

Fig.4. Participation in adult education and training activities by level of education [5].

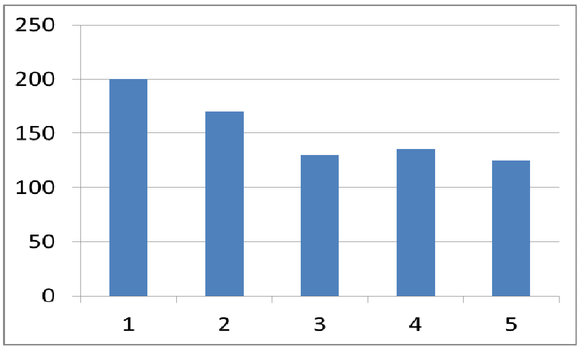

Fig.6. Number of persons who have completed primary education for adults

2.1. Basic adult education - an overview of participation in a five-year period

349 people were involved in the basic adult education at the end of the school year 2008/2009, representing a slight increase compared to 2008 (329 persons), and 2007(289 people), no significant decrease compared to 2005 (484 persons) and 2006, when this activity included 495 adults.

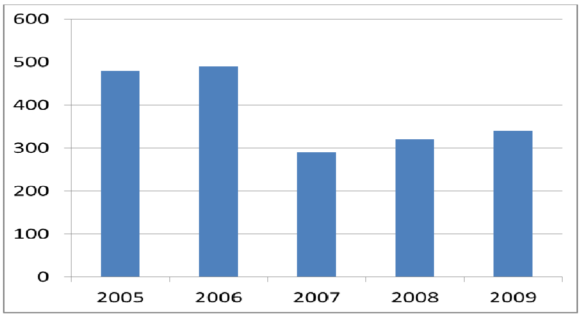

Fig.5. Number of persons involved in basic adult education [6].

In the same period there is a decline in the number of adults who have successfully finished their primary education. Since 2005, when 202 people finished basic training, 2006(169 people), 2007(131 people), 2008(136 people) till 2009, when the, activity ended with 125 people, almost twice less than the figure five years earlier.

2.2. Adult secondary education - an overview of participation in a five-year period

Persons involved in secondary adult education has not significantly varied in the period from 2005 till 2009 thus, in 2005 this educational activity included 6789 people, in 2006 with 5565 people, 2007 with 6913 people, 2008 with 6843 people. In 2009 6407 adults participated in secondary education.

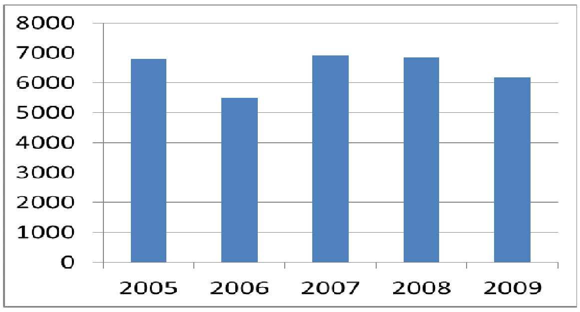

Fig.7. Number of persons involved in adult secondary education [6].

Persons who have completed their secondary education grew from 2005 till 2008 and in 2005 amounted to 2574 persons, 2006 2689 people, and 2007 2878 people and in 2008 3120 people. There was a decrease in the number in 2009, when 2687 adults finished high school.

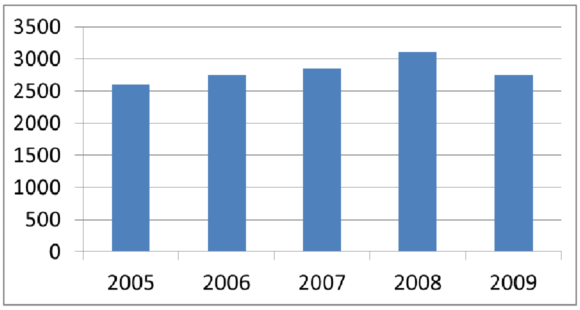

Fig.8. Number of persons who have completed secondary education, adult

2.3. Current data on participation in formal adult education programs

According to data from the Agency's database of vocational and adult education, formal adult education programs in the Republic of Croatia, 18187 participants attended. Of these, 10702 men (58.84%) and 7485 women (41.16%). Most of the participants (65%) were employed, 33% were unemployed, a little less than 3% of participants were retired people and students. The average age of participants of formal adult education programs is 30 years.

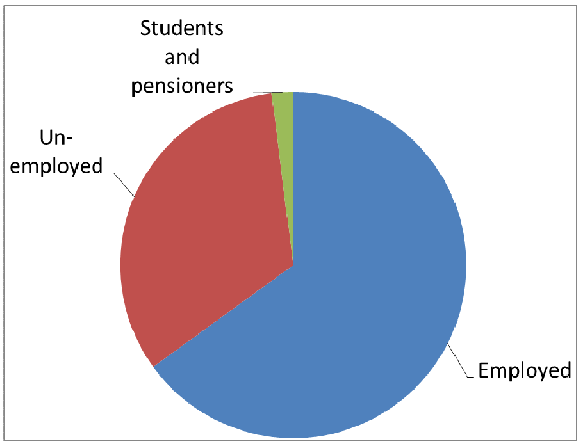

Fig.9. Students of formal adult education programs by working status

The data from the database of the Agency for Vocational and adult education suggest that half of all persons who participate in formal adult education are included in training programs. A large number of students involved in programs of acquiring secondary education / retraining (26% of all participants), 11% of students are involved in training programs, a slightly smaller number (9.5%) attend foreign language programs. In other programs - adult education programs in primary, semi-skilled occupations and the acquisition of secondary education involved a much smaller number of participants - together about 3.5% of all participants.

Table 4. Participants of formal adult education programs by program type [8].

TYPE OF PROGRAM	*SHARE*
Adult Basic Education	1.97%
Basic qualification	0.01%
Acquisition of secondary education / retraining	26.36%
Acquisition of secondary school diplomas	1.51%
Foreign Languages	9.50%

2.4. The time that students devote adults education and training activities

Adults in Croatia participating in the activities of education and training, formal and informal, on the average, devote 134 hours to these activities. In this respect Croatia is even above the EU average, which is 123 hours. This means that those involved in adult education activities devote a lot of time. However, given the low rate of participation of the entire adult population in adult education, this data suggests that in relation to the European average there is a below average number of adults in Croatia involved in adult education, who devote above average amount of time to this activity.

2.5. Willingness to participate in adult education and barriers to inclusion

Data on the willingness of adults to participate in education and training show the motivation for participation in adult education activities. Slightly less than 2 / 3 of adults in Croatia did not participate and do not want to participate in these activities, together with those who participated, but have no desire for further involvement means that 73% of adults in Croatia show no ambition to engage in any activity of education and training.

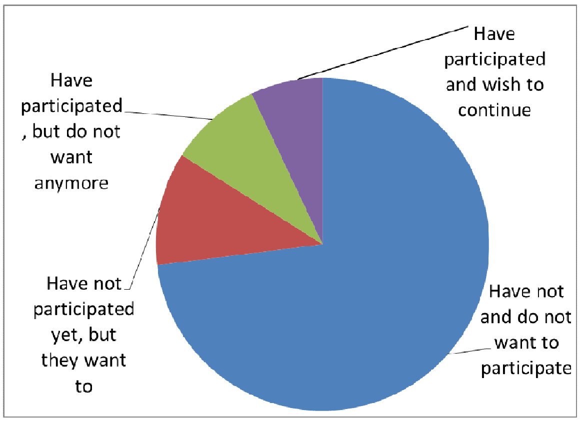

Fig.10. The willingness of adults in Croatia to participate in education and training [5].

Given the low motivation to engage in the activities of adult education, special attention should be paid to persons who are not participating in these activities, but would like to. The most common barriers to the participation of these persons is a high price and lack of time due to family commitments.

Table 4. Barriers to the inclusion of interested adults in Croatia in educational activities and training [8].

Too high a price	53.8%
Lack of time due to family commitments	48.7%
The overlap of the working hours	28.8%
The lack of programs available within a distance	26.7%
Lack of employer support	17.1%
The lack of required prerequisites	14.9%
Health or age	11.0%
Other	8.6%
Reluctance to return something that is reminiscent of school	4.2%

Too high price barrier is equal for men and women. However, lack of time due to family commitments as an obstacle appeared much more common for women (53.8%) than men (40.6%). On the other hand, the overlap of working time is a barrier for 37.5% of men versus 23.3% women. Men's restrictions on participation in adult education are more common because of lack of programs available within the distance (30.3% men versus 24.5% women), lack of support from employers (22.8% versus 13.6% women),health and age (13.8% men versus 9.2% women), and unwillingness to return back to school (5.1% men versus 3.6% women). Women are, however, more often confronted with the lack of required conditions (15.8%) than men (13.4%).

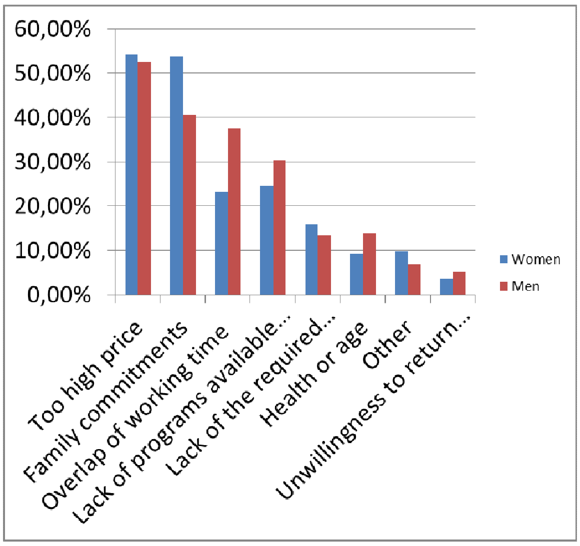

Fig.11. Barriers to the inclusion of interested adults in Croatia in the education and training men and women.[5].

2.6. Formal adult education - adult education institutions

In Croatia there are a total of 416 institutions for formal education of adults, the most common type of institution is the high school. The average number of students per institution was 44, and the average number of programs at the institution is 12.

According to data from the Agency's database of vocational and adult education in Croatia, the formal adult education programs are conducted in 416 institutions. Adult education institutions have an average of 43.7 students, carried out 12 programs and 16 teachers hired. In each educational group there is an average of 7 students.

The largest number of institutions for formal education of adults, 31% of them are small institutions with fewer than 5 workers. Facilities that have 50-10 employees constitute 6% of all institutions, 13% have 10-20 employees, 10% have 20-30employees, 21% of 30-50 workers, and 19% of institutions had more than 50 workers.

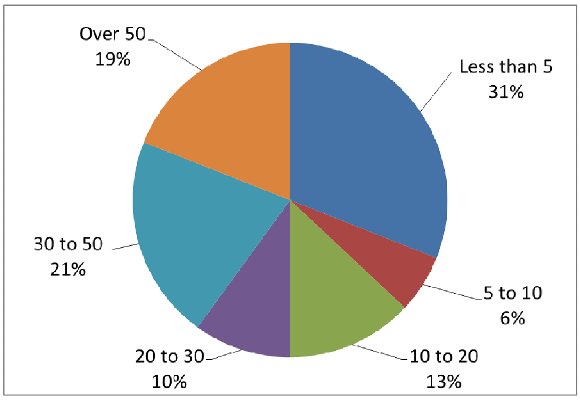

Fig.12. *Facilities for formal adult education by the number of workers [8].*

Something less than a quarter of institutions for formal education of adults (38%) are licensed to perform less than 5 programs, 21% of 50-10 programs, 8% 20-30 of such programs, 9% from 30 to 50.7% from 50 up to 100 programs, and less than 2% of establishments are licensed to more than 100 adult education programs.

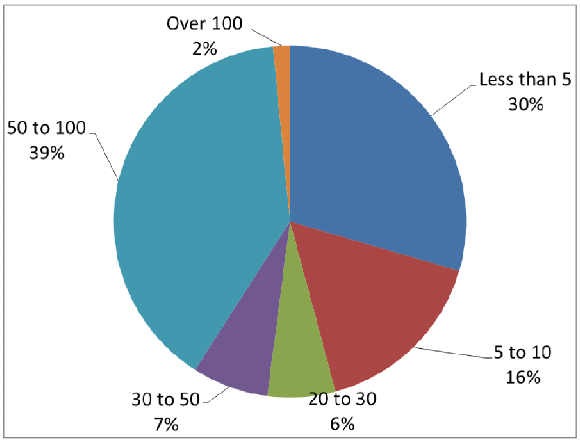

Fig.13. *Facilities for formal adult education by the number of programs [8.]*

2.7. Informal education - providers of informal adult education and training

In the concept of lifelong learning, great importance is attached to all forms of learning, regardless of the framework within which they occur. In addition to the formal educational, skills can be acquired through formal and informal learning. Activities of informal education and training involving adults in Croatia usually take place in non-formal education and training (24.2%) or by employers (22%). A number of activities are taking place in institutions of formal education (15.6%) and various commercial organizations (12.8%) while only a small part of the activities taking place in a different framework - the employers' associations and chambers have organized activities of 5%, non-profit 3.3%of the organization of activities, non-commercial institutions that are not primarily educational activities of 1.6% and 0.4% of trade unions activities. Finally, the individual tutoring accounts for 0.8% of the activities of informal education and training with the participation of adults in Croatia.

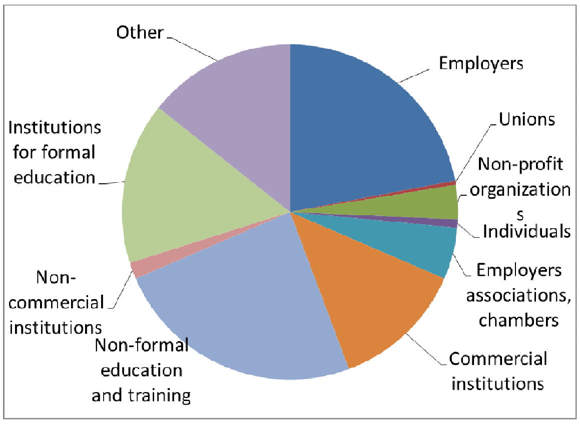

Fig. 14*: Activities of non-formal education and training by types of providers [5].*

3. CONTENT OF ADULT EDUCATION

4994 formal adult education programs were registered in Croatia, the most common type of formal adult education is the training, the most common area of formal adult education programs is the area of technology, manufacturing and construction and the most common area for informal adult education programs are social science, business and law.

3.1. Formal adult education programs

According to data from the Agency's database of vocational and adult education in Croatia there are 4994 formal adult education programs. More than four-fifths of all the programs are training programs (2661) and acquisition programs secondary education /retraining (1510).

Table 6. *Formal adult education programs by type[8]*

Training	2661
Acquisition of secondary education/ retraining	1510
Specialization	407
Foreign Languages	286
Applications requiring lower qualifications	59
Primary education	37
Acquisition of secondary school diplomas	34

Programs related to technical fields, manufacturing and construction were the most represented among the formal adult education programs 31, and 25.6% of all formal adult education activities related to this area. Followed by programs in social sciences, business and law (22.1% of all activities) and services (14.5%), while other areas represented a smaller percentage.

Table 7. *Formal programs of adult education and training in areas (2007)$_{32}$ [5].*

Techniques, manufacturing and construction	25.6%
Social sciences, business and law	22.1%
Services	14.5%
Natural Sciences	8.9%
Health and social care	7.4%
Education	6.9%
Humanities and Arts	5.3%
Computing	4.5%
General Programs	4.1%
Life sciences	2.8%
Agriculture and veterinary	1.7%

The current data of the Agency for Vocational and adult education related to the first half of 2010 shows that construction is again in the first place among the formal education of adults, and 25.6% of the expert opinion submitted to the Agency belonged to this sector. Agriculture, nutrition, veterinary medicine (14.82%), tourism and catering industry (14.10%) are also highly represented sectors while in the last place; with the lowest number of programs (0.36% of total) was art.

Table 8. *Applications submitted to the expert opinion of the Agency for Adult Education by Sector (In the first six months of 2010 [8].*

Construction & Surveying	22.77%
Agriculture, food and veterinary	14,82%
Tourism and Hospitality	14.10%
Economy, trade and business administration	10.72%
Mechanical engineering, shipbuilding and metallurgy	9.16%
Without sector	5.90%
Electrical Engineering and Computing	5.78%
Transportation and Logistics	5.78%
Personal protection services and other services	5.30%
Forestry, wood processing	2.29%
Textile and leather	1.20%
Health and Social Care	0.96%
Graphic technology and audio-visual design	0.84%
Art	0.36%

3.2. Informal adult education programs

The most frequent area of activity of non-formal adult education 34% were social sciences, business and law, and 24.1% activities refer to the area. Followed by natural science (16.4% of activities), services (14.8%), the use of computers (12.5%), humanities and arts (11.2%) and health and social care (10.4%), and other areas of informal education and training activities have included a smaller percentage.

Table 9*: Informal adult education and training in areas [5].*

Social sciences, business and law	24,1%
Natural Sciences	16.4%
Services	14.8%
Using computers	12.5%
Humanities and Arts	11.2%
Health and social care	10.4%
Techniques, manufacturing and construction	9.6%
Foreign Languages	8.7%
Education	4.7%
General Programs	2,6%
Computing	2,5%
Agriculture and veterinary	1.6%
Life sciences	0.9%
Natural sciences (wider channels)	0.5%

Within the formal education and training there is a special significance to informal adult education related to the job - 78.1% of adult non-formal learning refers to this type of activity.

4. TEACHERS IN ADULT EDUCATION

The Republic of Croatia has 6681 registered teachers in the formal education of adults, the proportion of women in the figures is 65% and the proportion of teachers who work under a contract is 53%.

4.1. Teachers in formal adult education

According to the data from the Agency's database of vocational and adult education in Croatia there are 6681 teachers in adult education. Every fifth teacher (19%) works in Zagreb and Counties with the least number of teachers in adult education are Krapina-Zagorje, Primorsko-goranska and Lika-Senj. Two-thirds of all teachers (65%) are women, a third (35%) are men.

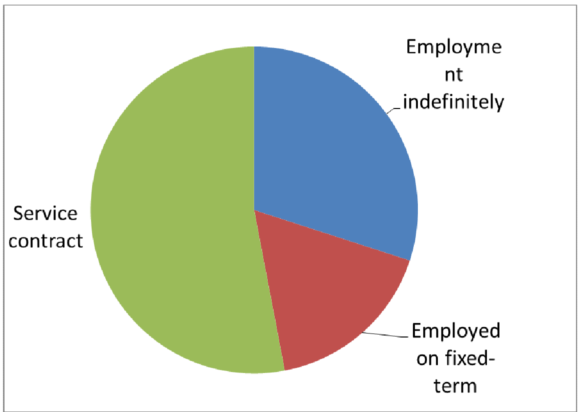

Fig. 15. Teachers in adult education by type of employment [8].-(Figure does not include teachers in primary and secondary schools. Where most engaged in Adult education also teaches in the regular classroom)

Most of the teachers (not including teachers in primary and secondary schools) in institutions are engaged under a contract of work, 53%. In the course of employment for an indefinite period is 30% of teachers and 17% were employed at some time.

4.2. Teachers in secondary education for adults - overview of the five-year period

Number of teachers engaged in the secondary education of adults in 2005 year was 1779, and has not changed significantly by 2009 when it was at 1752. To a certain decrease in the number of teachers came in 2006 when this segment of adult education was hired 1523, and in 2007, when in high school adult education teachers was 1589.

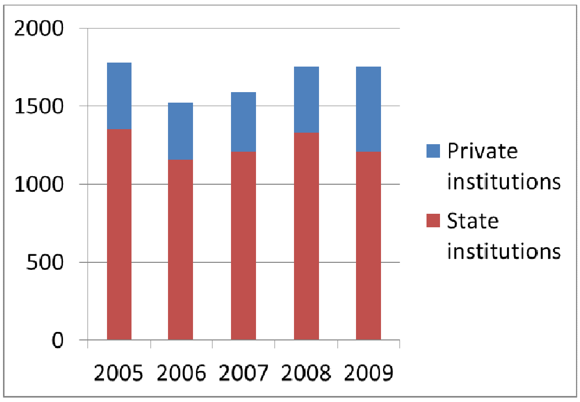

Fig. 16. Number of teachers in secondary education for adults since 2005. until 2009 [7].

Although the total number of teachers has not been significantly altered, changing the type of institution in which the teachers engaged in secondary education for working adults. Thus, the share of teachers who worked in private institutions increased by 24%, which was the 2005th to 31% as it was the 2009th. On the other hand, the share of teachers who work in public institutions declined from 75% as in 2005 to 69%, which was the 2009th

The data refer only to teachers hired in institutions that have implemented programs for the acquisition of secondary and primary school qualifications, and do not include those working in institutions that have implemented only the retraining programs, training and training.

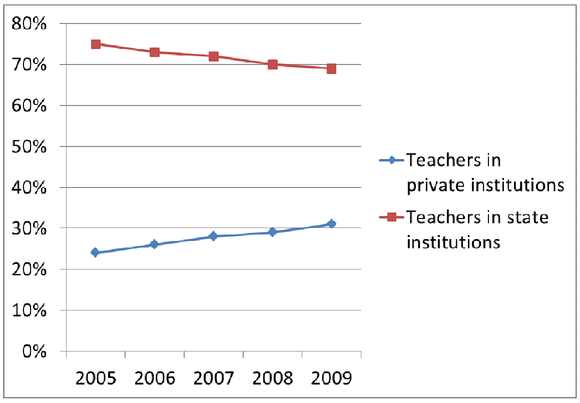

Fig.17. Teachers in private and public institutions [8].

5. FINANCING OF ADULT EDUCATION

In Croatia, the share of students who pay for their attendance of the formal education of adults is 61%, the average cost of training is 2.887 Croatian Kuna (KN), and the average annual location of participants to the activities of education and training is 1626 kunas.

5.1. Sources of funding to attend formal adult education programs

In most cases, I paid attendance of participants (61%). Employers finance 18% of students who attend formal education of adults, the Croatian Employment Service 9% of participants while attending the adult education program for only a small part of the students funded from other sources. County by funding 4% of participants, build 2%, the Ministry of Science and Technology is also 2%, and other ministries of less than 1% of all participants.

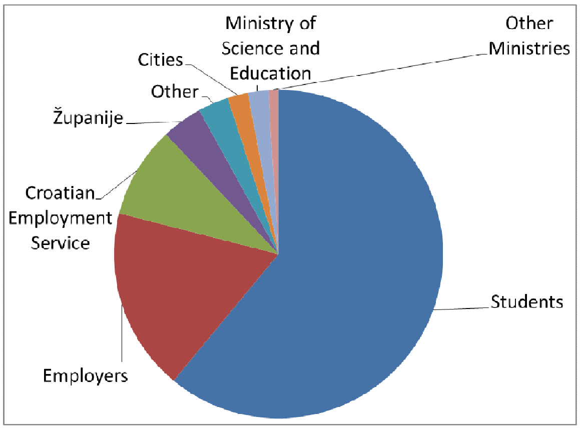

Fig. 18. Sources of funding to attend adult education programs [8].

5.2. Price formal adult education programs

The most expensive formal programs of adult education programs are gaining a secondary school education, with an average price of 10.000 KN, and the least expensive training programs, with an average price of 2.887 KN.

Table 10. *Average price of formal adult education programs (data relating to the institutions they enter information about the cost of the program) [8].*

Program acquisition of secondary education	10.000,00 kn
Program acquisition of secondary education / retraining	9.221,41 kn
Training program	7.996,46 kn
Retraining program	6.342,41 kn
Program Low-skilled	4.227,27 kn
Training program	2.887,05 kn

5.3. Allocation of students for education and training

Students in Croatia for the education and training of adults on average annually allocated 1.626 KN (225 €). By this indicator, Croatia is very close to the EU average, which amounts to 1.778 €, and by this criterion of 24 countries for which data are available is equivalent to 12 place. As the data in the number of hours students devote to education and training, and this fact suggests the conclusion that the Adult Education in Croatia which is a quality very close to the level of European countries, but includes a much smaller portion of adult citizens.

Isolation of adult education and training per participant was mostly in the youngest category of adults, 25-34 years, and this category of participants in these activities in a year spent 1.821 KN. This amount is only slightly lower for the next age group from 35-54 years, and people who fit into this category of students spent an average of 1.677 KN on education and training activities. For this purpose, at least they pulled students 55-64years of age, where the average expenditure for education and training amounted to 491 KN.

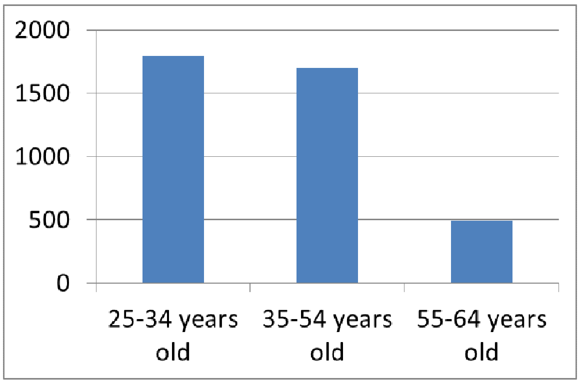

Fig. 19.: Annual average allocation of students to adult education and training by age [5].

5.4. Allocations employers for professional education of employees

Given that the data in a database of the Agency for Vocational and adult education programs attend formal adult education for 18% of students financed by employers is an important indicator of funding for adult education are the monthly allocations of employers for professional training of their employees.

Nearly a third of employers (31%) per month set aside less than 500 for the professional training of employees. The 14% set aside 501-1.000 KN, 15% 1.001-2.000 €, 20% 2.001-5.000 and 8% 5.001-10.000kn. Only 13% of employers for purposes of this month set aside more than 10.000 KN.

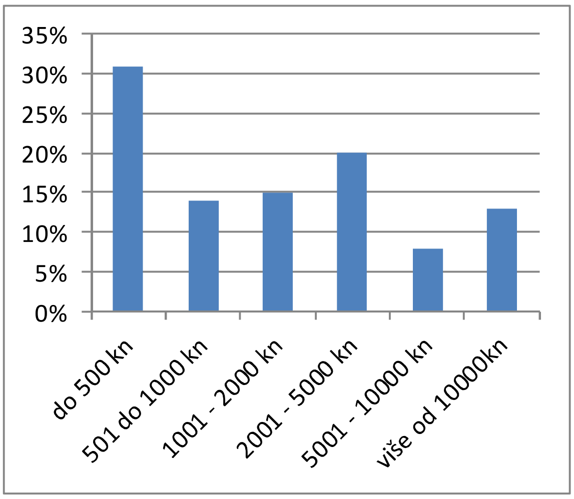

Fig. 20. Monthly expenditure of employers for vocational training of employees

5.5. Financing of adult education in 2010 year from the budget of the Croatian

For purposes of this paper was sent to inquire about the funds intended for adult education in 2010 year all ministries (16) in the Republic of Croatia and the Croatian Employment Service. At the request was responded to 13 ministries and the Croatian Employment Service. Of these, three ministries replied that in this 2010-year plans have no funds for this purpose. Total planned resources to the data collected in 2010 amount to 118.436.609,00 KN in the first six months of 2010. year was spent 84.083.184,29 KN. Below are tables showing the total amount of planned funding for adult education positions in ministries and the Croatian Employment Service and a brief description of the target group that funds meant for.

According to data collected most of the funding for adult education will be spent through the program of the Croatian Employment Bureau 48 million Kuna. If we take into account planned and used resources is also evident that the largest percentage of funds used in the first half of 2010 year was the Croatian Employment Service (47.141.243,00 KN).

6. CONCLUSION

Croatian Academy of Arts and Sciences, in December 2002. , adopted and published the "Declaration on Knowledge", which indicates the importance of knowledge as the main lever of growth and development of education and science to the global quality criteria, as a first step towards a knowledge society. Increase spending on education and science must be a priority in development policies and certificates of European orientation.

Croatian Government and the National Competitiveness Council, in March 2004. Presented the "55 Recommendations for improving the competitiveness of Croatian", and highlighted four key national strategic objectives: achieving sustainable GDP growth, decreasing unemployment, increasing quality of life and increase the degree of social involvement.

The attainment of these goals is based on education for the growth and development. "Each national economy and its competitive position depend primarily on the quality of human resources. Using these resources and invest in their quality are the main factors of development."

The adoption of the Strategy for Adult Education and Action Plan for Adult Education the Croatian Government has made substantial progress in improving the education of the population in the Republic of Croatia, a true indicator of the ten-year period will be visible in the data, which will include population census 2011 year.

However, the data analysed in this work are visible in the essential progress that Croatia has made in improving the educational structure of population, education, labour market, as well as greater allocation of funds for these purposes.

On the verge of joining the European Union, Croatia await new challenges on the economic front and on the European market in conjunction with anything will be required to work more on educating people for the labour market as a result of structural and other social and economic change.

In this sense, key steps are in the development of adult education institutions, quality of programs and teaching staff, better use of resources from EU funds and increased appropriations from the state budget.

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Influence of agrochemical properties of the substrate on the germination of radicchio (*Cichorium intybus var. Foliosum* Hegi.)

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Abstract

Standard germination and germination energy as the main indicators of physiological seed quality are often limited by agrochemical properties of the substrates which are required for seed germination. In the first instance that are pH and EC of the substrate, which directly affect to the number of normal seedlings and normal root system development as well as hypocotyl and seedling mass. The aim of this study was to determine the effect of agrochemical properties of three different substrate on germination characteristics of radicchio. The experiment was set up under controlled conditions in forcing bad of University of Applied Sciences in Slavonski Brod during November 2010. In plastic containers for growing seedlings (100 seeding posts 3x3 cm), on three different substrates Green vital, Acid substrate and H Potgrond was planted four different varieties of radichio: Bianco di Milano, Castelfranco, Pan di Zucchero, and Verona with three replications. The differences found in pH and EC between all three substrates were highly significant (F> 0.01 **). Statistically significant effect of substrate on root length was found. Also, the variety Caselfranco was statistically significantly different from other varieties by standard germination, hypocotyl length and root length. From these results we can conclude that choosing the proper substrate for growing seedlings radicchio plays a major role in seed germination and root development.

Key words: Substrate; Agrochemical properties; Radicchio.

1. INTRODUCTION

Seed germination as one of the components of the seed quality is a characteristic which accompanied with environmental conditions and genotype have a considerable influence on the production of the biomass of growing plant [1]. Determination of seed germination with standard germination test (ISTA) was conducted under ideal conditions therefore these results are valid only for optimal field conditions (Te Krony 1995, Siddique and Wright 2004), and standard germination usually exceed field germination (Hamman et al. 2002) especially when the pH values of the soil are low [2]. Standard germination and germination energy as the main indicators of physiological seed quality are often limited by agrochemical properties of the substrates that are required for seed germination. For professional vegetable grow it is necessary to use substrate according to the needs of cultivar. That specific substrate has to have required pH and EC values, ratio of micro and macro nutritious according to phenological fase and vegetable species, and by structure it has to be middle to large fraction. Most of the vegetable plants favours neutral pH reaction of the soil with bigger tolerance to acid rather than alkaline pH reaction [3]. According to Lešić at al. (2004) pH reaction of the soil which is optimal for radicchio is 4,5-5,5 [4]. Although in Croatia because of the influence of humid climate there are negligible amount of salted and alkaline (sodic) soils. In greenhouses, as a result of the use of large quantities of the mineral fertilizers or irrigation by water with high concentration of salt, the substrate can became salted [5]. Therefore the aim of this study was to determine the effect of agrochemical properties of three different substrate on germination characteristics of radicchio.

2. METHODS AND MATERIALS USED FOR RESEARCH

The experiment was set up under controlled conditions in forcing bad of University of Applied Sciences in Slavonski Brod during November 2010. In plastic containers for growing seedlings (100 seeding posts 3x3 cm), on three different substrates Green vital, Acid substrate and H Potgrond was planted four different varieties of radicchio: Bianco di Milano, Castelfranco, Pan di Zucchero, and Verona with three replications. Measuring of the pH and EC values of substrates has been conducted in the laboratory of University of Applied Sciences, Slavonski Brod, by the pHmetar and ECmeter with three replications. Average pH value of substrate were for Green vital 7,7, Potgrond 5,8 and for the acid substrate 4,5. Measuring of the EC showed average values for Green vital 1155µS/cm, Potgrond H 1086 µS/cm and for the acid substrate 371 µS/cm. Temperature during germination was 20,7°C, and the moisture was 77%. During the experiment germination and germination characteristics have been determined: germination energy, standard germination, length of the root, length of the hypocotyl, length and mass of the sprouts. Energy of germination was determined after 4 and all other measures after 7 days. Measurement has been done on all of the sprouts.

3. RESULTS AND ACHIEVEMENTS

Three analysed substrates that were included in this study are basically distinguished by pH and EC. pH were from 4,53(Acid substrate) to 7,07 (Green Vital) and EC from 371 to 1155 µS/cm (table 1). Also, the differences found in pH and EC between all three substrates were highly significant (F> 0.01) (table 1). However, when we consider the influence of pH and EC of the substrates on seed germination of radicchio then is statistically significant influence determined only on the root length between Green Vital and Acid substrate. The longest root was measured at the lowest pH and lowest EC at the Acid substrate 2.22 cm, while the Green Vital with the highest pH recorded the shortest root 1.80 cm. Root length at Potgrond H substrate was 2.16 cm and statistically significant correlation was not found no matter what the EC of the substrate was the highest (table 1). However, in all other parameters of germination statistically significant difference was not determined which is not in accordance with other authors. Namely, Grljušić at al. 2007. [6] found that pH values of water solution significantly influenced to standard germination, root length, hypocotyl length and total weight of seedlings. The same authors recorded the significantly longer root at lowest pH which is conforming in our results. Also, influence of EC to germination is very important and as Sun at al. 2009. [7] recorded that the high EC significantly decreased the biomass, chlorophyll content, photosynthesis and transpiration rate. According to these authors planting tolerance EC varieties could be a good solution for seedlings radicchio on substrates with high EC. In our research, only the variety Castelfranco

Table 1. Substrate impact to germination

Substrate	pH	EC	Germ. energy	Standard germ.	Seedlings mass (g)	Seedlings length (cm)	Hypocotil length (cm)	Root length (cm)
Green Vital	7.707 A	1086 B	40.58 A	64.58 A	0.021 A	4.35 A,B	2.82 A	1.80 B
Potgrond H	5.823 B	1155 A	44.92 A	74.83 A	0.014 A	4.99 A	2.56 A	2.16 A,B
Acid substrate	4.527 C	371 C	54.33 A	70.42 A	0.014 A	4.77 A	2.56 A	2.22 A

$P \leq 0{,}01$ A,B

was statistically different from other varieties by standard germination, hypocotyl length and root length (F> 0.01) (table 2).

In relation to all other varieties the variety Castelfranco had the lowest germination parameters (germination energy, standard germination, seedlings length, hypocotyl length, root length) except seedlings mass which was equal to other varieties (table 2).

Germination energy of Castelfranco was five time lower than the Bianca di Milano (12.00, 64.00, respectively) and standard germination was twice lower in comparison to other varieties. Also, seedlings, hypocotyl and root lengths were low and it is all a consequence of the high sensitivity of the Castelfranco variety to growing conditions.

This experiment was conducted in controlled environmental conditions (optimal) therefore the seeds were not exposed to other stress conditions such as extreme temperatures or flooding stress etc. which were possible in the field conditions, what opens new perspectives for further investigations.

4. CONCLUSIONS

Agrochemicals, biological and physical characteristics of the substrate is essential for quality growing seedlings and the primary role have pH and EC. Another important aspect is the proper varieties selection resistant to different growing conditions. So, choosing the proper substrate for growing seedlings radicchio plays a major role in seed germination and root development. Equally important was the selection of planting radicchio varieties and susceptible varieties can result in very low germination where the quality of seedlings will be inadequate.

5. ACKNOWLEDGEMENTS

This paper is a part of Graduation Seminar of Ivan Sedlar, Bachelor of University of Applied Sciences of Slavonski Brod.

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Table 2. Variety characteristics impact to germination

Variety	Germination energy	Standard germination	Seedlings mass (g)	Seedlings length (cm)	Hypocotil length (cm)	Root length (cm)
Bianca di Milano	64.22 A	85.11 A	0.015 A	5.139 A	3.02 A	2.13 A
Castelfranco	12.00 B	39.33 B	0.018 A	3.279 B	1.81 B	1.47 B
Pan di zucchero	50.22 A	77.11 A	0.015 A	5.011 A	2.79 A	2.22 A
Verona	60.00 A	78.22 A	0.017 A	5.377 A	2.96 A	2.41 A

$P \leq 0,01$

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Pseudogley characteristics, distribution and limitations in plant production on the County of Slavonski Brod-Posavina area

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Abstract

The aim of this paper was to determine the distribution and characteristics of hydromorphic soils, class pseudogley soil, soil type pseudogley of County of Slavonski Brod-Posavina. According to Basic Soil Map of the Republic of Croatia (scale 1:50000) and previous studies in these investigation area 17 soil types were determined, of which 10 belong to automorphic soils, and 7 to hydromorphic soils. Pseudogley takes about 36184,4 ha in County of Slavonski Brod-Posavina (Brodsko-posavska County). The texture of these soils is silty clay loam in surface and subsurface horizon with content of clay between 10,4 to 36,1%. Soil structure agregates are very unstable. Pseudogley soils in this area are characterized by a low to very low air holding capacity and low to medium retention water capacity, also water drainage is low to absolutely watertight. It was determined that soils are vary from very to low acid (pH KCl 3,96 to 5,66) and show low to moderate supplies of potassium. Supplies of phosphorus are very variable (0 to 30 mg/100 g soil), also content of soil organic matter is in wide range (from 0,2% to 7,02%). Main limiting factors of pseudogley for plant production are presence of watertight pseudogley (g) horizon, high density, low infiltration, low air capacity, high soil plasticity and low phosphorus and potassium content.

Keywords: Pseudogley; Soil properties; Soil suitability; County of Slavonski Brod-Posavina.

1. INTRODUCTION

According to Basic Soil Map of the Republic of Croatia (scale 1:50000) and previous studies in County of Slavonski Brod-Posavina (Brodsko-posavska County) 17 soil types were determined, of which 10 belong to automorphic soils, and 7 to hydromorphic soils. Pseudogley takes 577025 ha (10,363 percent) of all soils in Croatia [1] while in County of Slavonski Brod-Posavina (Brodsko-posavska County) pseudogley takes about 36184,4 ha [2].

Prolonged water saturation and seasonal alternation between water logging and drainage has profound effects on soil chemical and morphological properties by hydromorphyc soils, in which belong pseudogley [3]. Pseudogley is a soil type that is under natural conditions characterized by unfavourable properties, the most pronounced being insufficient amounts of basic plant nutrients. The existence of poor physical, chemical and biological properties of the pseudogley soil type is a complex problem occurring in plant production organization on the soil. Of the chemical ones, the most commonly investigated seem to be pronounced soil acidity, increased aluminium and manganese contents, alkaline cation deficiency in the adsorption complex and reduced available phosporus content (Okiljević , 1982; Dugalić, 1997; Radanović and Predić, 1997) [4].

The aim of this paper was to determine the distribution and characteristics of hydromorphic soils, class pseudogley soil, soil type pseudogley of County of Slavonski Brod-Posavina, also main limiting factors of pseudogley for plant production.

2. METHODS AND MATERIALS USED FOR RESEARCH

Soil map at the scale of 1:100000, corrected with new topographic data, have been used for determination of the distribution of pseudogley in Brodsko-posavska County. Afterwards correction and update have been done with Basic Soil Map at the scale of 1:50000 [5] and other data from detailed pedologic research for the needs of agro technical and hydro technical meliorations on the soils of ex agro-industry of County of Slavonski Brod-Posavina [2].

Pedologyc maps were made by the criteria used for detailed maps [6, 7]. Soil type map were made by GIS tool ARCVIEW 3.3.

Table 1. The areas of pseudogley soil types in County of Slavonski Brod-Posavina

No	Soil types	Area, ha
1	Pseudogley	21767,7
2	Pseudogley hydromeliorated with canals	2964,9
3	Pseudogley hydromeliorated with drainage	11451,8
	Total:	36184,4

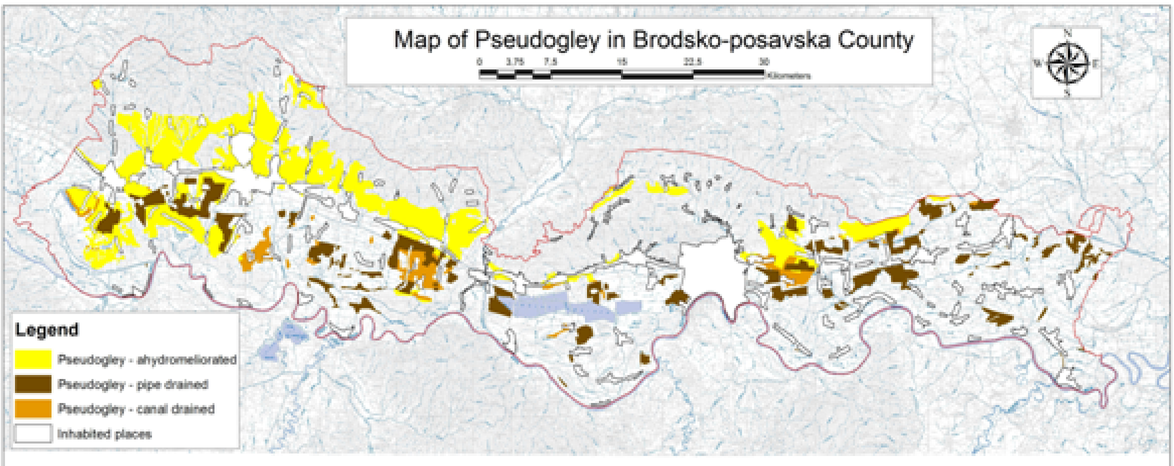

Fig. 1. Map of distribution of pseudogley in Brodsko-posavska County (County of Slavonski Brod-Posavina)

3. RESULTS AND ACHIEVEMENTS

The areas of pseudogley soil type in Brodsko-posavska County is determined according to legend of pedologic map of that county. The distribution of pseudogley soil type has been shown on map (Figure 1) and that classification has been made by the pedogenetic principals according to contemporary soil classification [8].

Total pseudogley area was 36184,4 ha of which hydromeliorated with canals were 2964,9 ha and with pipe drainage 11451,8 ha (table 1).

Pseudogley areas in agricultural production without melioration takes 11406,1 ha, hydromeliorated with canals 2609,9 ha and with pipe drainage 11451,8 ha, the rest are forests and forest soils. Total areas of mapped units is 177132,2 ha.

On the basis of analytical data for pedologic profiles from the instructions of Basic Soil Map of the Republic of Croatia at the scale of 1: 50000 and monography Soils of Slavonia and Baranja [9] in the tables 2 and 3 the results for physical and chemical characteristics of hidromorphic soil (surface water gley soils, pofile A-Eg-Bg-C), class pseudogley, soil type pseudogley were displayed.

They varied from very to low acid (pH KCl 3,96 to 5,66) and showed very variable supplies of phosphorus (0 to 30 mg/100 g soil) (table 2). The low fertility of acid soils in Croatia is mostly due to inadequate level of available phosphorus (Kovacevic and Banaj, 2004, Kovacevic et al., 2005) [10]. According Jelić et al. (2011) the low pH of pseudogley soils and deficiency of major biogenic nutrients, primarly P and Ca, are factors constraining high stable yields of cultivated plants [11]. Using different amelioration measures, numerous researchers have tried to overcome the problems resulting from soil acidity (increased aluminium and manganese contents, deficiency of alkaline cations in the adsorption complex and reduced available phosphorus content) [4]. It is generally know that liming increase the availability of phosphorus and soil alkaline cations and reduces the availability of most heavy metals. In investigated soils, supplies of potassium are low to moderate, while content of soil organic matter is in wide range (from 0,2% to 7,02%). According to the investigations of some autors, significantly higher leaf contents of P, Ca and Mg were found on alkaline soil compared to acid soils, while differences in K levels were not statistically significant [12]. Quantity of total nitrogen, in these soils, varied from moderately to low in surface horizon, in subsurface horizon content was very low. Soil analysis showed that forest pseudogley soils had the highest content of humus in the humus horizon, while it was lower in meadow, arable land had lowest average humus content and it is strong depend of land use [13].

Table 2. Soil chemical properties

Soil	Horizon	pH (KCl)	Total-N (%)	AL-P2O5 mg/100g	AL-K2O mg/100g	OM (%)
Pseudogley	A or P	4,28-5,00	0,06-0,16	0,80-30,00	3,00-7,50	0,65-2,20
	Eg	4,04-4,74	0,06-0,08	0,00-1,00	4,40-5,00	0,47-1,50
	Btg	3,96-4,84	-	1,70	4,00-5,50	0,20-0,65
	Cg	3,96-5,66	-	0,70	4,80-7,30	0,95-7,02

Table 3. Soil physical properties

Soil	Horizon	Bulk density, ρv (g/cm3)	Holding capacity Water, (% vol.)	Air (% vol.)	Porosity (%)	Clay (%)	Infiltration (10-5 cm/s)
Pseudogley	A or P	1,24-1,50	34,9-38,7	4,8-9,3	44,5-54,2	10,4-21,87	0,015-3,9
	Eg	1,42-1,51	36,9-39,1	2,82-6,5	42,1-44,4	19,25-36,11	1,6-2,3
	Btg	1,40-1,53	35,2-37,1	7-8,3	44,2-48,5	17,08-37,20	5,1-7
	Cg	1,52-1,65	36,7-37,8	5,7-7,74	43,2-44,49	23,73-43,90	0,0

The texture of these soils is silty clay loam in surface and subsurface horizon with content of clay between 10.4 to 36.1%. Soil structure agregates are very unstable. Pseudogley soils in this area are characterized by a low to very low air holding capacity and low to medium retention water capacity, also water drainage is low to absolutely watertight. According to Renger, bulk density of these soils has been moderately in subsurfaces horizons and low to moderately in surface horizon.

The yields of crops grown on pseudogley depend very much on the annual distribution of atmospheric precipitations, whereas one of the most important processes closely related to soil formation is the translocation of fine soil particles or leaching of clay particles from the upper soil horizons and their accumulation in deeper layers [14]. The location of impenetrable horizon (Resulović et al., 1972) and high share of powder fraction are the most important causes of unfavourable water-air, physical and textural characteristics of the pseudogley [15]. According Iwama (1980) pseudogley soils were characterized by the presence of impermeable layers in the shallowers horizons, low retentive capacity and low unsaturated hydraulic conductivity of the subsoils [16]. Some authors qoute thath macropores contributed greatly to root elongation. In pseudogleys, infiltrations occured preferentially in macropores. The macropore system allowed the unevenly distributed roots to take up water easily [17].

According to suitability of pedosystematic units for intensive farming pseudogley belong in Suitable order (S) – suitable for cultivation, Suitability class degree (S3) – restricted suitable. Main limiting factors in plant production in pseudogley on level terrain are waterlogging, poorly drained and strong sensitiveness against chemical polutants (v, dr_0, p_3). All this characteristics including terrain inclination (>15 and/or 30%) are limiting factors in plant production in pseudogley of slopes (v, n, dr_0, p_3) [18].

4. Conclusions

According to map of distribution of pseudogley in County of Slavonski Brod-Posavina and data from legend of pedologyc map of these areas (36 184.4 ha) it can be concluded that pseudogley is spread soil in that county. The results of chemical and physical properties of pseudogley showed that soil is limited suitability soil for plant production. High levels of waterlogging, presence of watertight (g) horizon, low supply P and K ($<$10mg/100g soil), low to very low drainage and high expenses of maintaining are the main limitating factors of pseudogley.

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The Effect of Mineral Fertilization on Annual Vine Shoot Growth

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Abstract

The fertilization of a vineyard contributes to the creation of a larger vegetative power in the vines, which can then be loaded with a higher number of buds, and thus help to achieve a higher yield of grapes. The fertilization is carried out with mineral and organic fertilizers. The experiment was set up on March 31, 2010 at a cultivar of Italian Riesling, using three different treatments in randomized blocks. Each block consisted of four vine trees. The effect of fertilization on the growth of annual shoots, on the number of nodes and leaves per shoot as well as on the number of clusters per shoot was analysed. In the experiment a complex NPK mineral fertilizer, the so-called „NPK (SO_3) 7-14-21 (24)" in the amount of 0.5 kg/vine tree, and the nitrogen fertilizer „KAN N 27" in the amount of 0.25 kg/vine tree were used. The mineral fertilization with „KAN N 27" as a nitrogen fertilizer yielded the highest average growth of the shoots during the growing season and also the highest number of nodes and leaves per shoot of the vine. The number of clusters did not change with respect to fertilization.

Keywords: Grapevine; Italian Riesling; Mineral fertilization; Annual shoot.

1. INTRODUCTION

On the basis of many analyses performed during one year growth cycle of vine grape (*Vitis vinifera* L.) and productivity of 6 kg to 18 t/ha, losses from soil for pure nitrogen are from 40 kg to 150 kg, for phosphorus from 10 kg to 60 kg, for potassium from 40 kg to 200 kg and for calcium from 25 kg to 100 kg. Fertilization of vineyard is usually made by mineral and organic fertilizers but combination of both types of fertilizers ensures the best commercial results [1]. In eastern part of continental region of Republic of Croatia (Brod – Posavina County) vineyards are placed on 90 m to 250 m above sea level. Total amount of precipitation is 640 – 850 mm per year and during the vegetation 350 – 430 mm. Average insolation duration during vegetation is 1500 – 1600 hours [2].

Nitrogen fertilization is one of the most common agrotehnical methods in vine grape production and this is the way to increase vegetation growth as well as grape productivity and maturation. Time of maturation is directly connected with differences in sugar contents, total acids, and contents of organic acids in grape. On varieties Chardonnay, Italian Riesling and Rhenish Riesling three different nitrogen fertilizations (23 kg N/ha, 70 kg N/ha and 117 kg N/ha) were made [3]. Authors analysed sugar contents as well as malic acid and citric acid contents. The results differed regarding to different amount of fertilizers. The difference was noticed at grape variety Rhenish Riesling during fertilization with 23 kg and 70 kg N/ha and on grape variety Chardonnay during fertilization with 117 kg N/ha [3].

The other experiment was set in western Austria and aim of research was to find the influence of nitrogen fertilization on vegetative and reproduction capability of vine grape with low content of nitrogen. During the irrigation of variety Cabarnet Sauvignon five different treatments of nitrogen fertilization (0, 50, 100, 200, and 400 g N / vine) were used. Vineyard was 12 years old and experiment lasted for three years. Nitrogen contents didn't show effect on total productivity in first and last of three seasons measured. However, the biggest total productivity came from vine grape treated with 100 g N / vine in second season measured. Extra application of 200 g and 400 g N/vine for getting extra total productivity is not justifiable. Greater number of grape berries was correlated with greater total productivity of vine grape. It seemed that mild treatment with nitrogen fertilizer had good effects on vine grape productivity in cases of low nitrogen contents in soil [4].

The aim of the work presented in this paper was to determine influence of two mineral fertilizers on growth of annual shoots for cultivar of Italian Riesling.

2. METHODS AND MATERIALS USED FOR RESEARCH

Vineyard used for experiments described in this paper was placed on location Bili Brig (at Nova Kapela near Slavonski Brod, Croatia) and it was property of Family farm „Željko Sameljak”. Experiments were set on March 31, 2010 in three treatments, as accident block layout with each block containing four vines. Treatments were as follows:

1. Control – no fertilization – CO,
2. Mineral fertilization (0.5 kg NPK / vine) – NPK,
3. Mineral fertilization (0.25 kg KAN / vine) – KAN.

Vineyard was set in 1993 with Italian Riesling variety and growth system was double side cordon. Constitution set of vineyard was as follows: 300 cm between lines and inside the lines it was 120 cm. Total area examined was 1212 m² and geography location was slightly high plateau around 150 m above sea, with southern exposition. Fertilizers used in this experiment were products of „Petrokemija d.d.”, Croatia, (complex NPK mineral fertilizer „NPK(SO_3) 7–14–21(24)”, and nitrogen fertilizer „KAN N 27”). At the end of vegetation season in year 2009 whole vineyard was fertilized with organic fertilizer by ploughing it into the soil.

This work presents influence of fertilization on the growth of annual shoots, on the number of nodes and leaves per shoot as well as on the number of clusters per shoot. To get information about growth of annual shoots measurements were performed every seven days (beginning from April 29, 2010 until June 12, 2010). Precise measurement dates were as follows: April 29, May 3, May 13, May 19, May 26, June 5, and June 12, 2010. Determination of numbers of nods, leaves and clusters was carried out every seven days beginning from May 13 until June 12, 2010.

3. RESULTS AND ACHIEVEMENTS

Table 1 shows the values of growth of annual shoots measured in seven different treatments during vegetation: Control – no fertilization, mineral fertilization with NPK 7-14-21 (7 % N), mineral fertilization with KAN (27 % N).

Table 1. Growth of annual shoots considering terms and treatments (in cm)

	Measurement terms						
Treatments	**29.04.**	**03.05.**	**13.05.**	**19.05.**	**26.05.**	**05.06.**	**12.06.**
CO	4a	9,2a	31,9a	38,1a	51,6	71,4	120,4
NPK	4a	9,4a	29a	34a	45,3	61,5	82,3
KAN	4,6a	10,1a	35,4a	43,7a	57,6	82,8	119,6

Mineral fertilization with KAN (nitrogen fertilizer) had the biggest average growth of annual shoots during vegetation. The obtained result was expected because of the fact that nitrogen has many known effects on vegetation production. The biggest difference in average of growth of annual shoots was noticed in last measurement (June 12, 2010) between Control and treatment with NPK fertilizer. The difference in size of annual shoots between Control and fertilization with KAN fertilizer was 0.8 cm.

Table 2 shows number of nods and leaves during five terms of measurements and treatments: Control – no fertilization, mineral fertilization with NPK 7-14-21 (7 % N), mineral fertilization with KAN (27 % N).

- Mineral fertilization with KAN gave the highest number nods and leaves during the growing season,

- Fertilization with both mineral fertilizers did not affect the number of clusters per shoot of the vine.

From these data it can be concluded that nitrogen fertilizer influenced the increase in

Table 2. Number of nods and leaves by terms and treatments

	Measurement terms				
Treatments	**13.05.**	**19.05.**	**26.05.**	**05.06.**	**12.06.**
CO	7	8	10	13	19
NPK	7	8	11	13	18
KAN	8	9	12	15	20

Mineral fertilization with KAN compared to Control and fertilization with NPK influenced (increased) number of nods and leaves throughout whole examination process. The differences between Control and fertilization with NPK were very small. Fertilization with NPK had “inferior” results (smaller numbers of nods and leaves have been obtained) comparing to nitrogen fertilization with KAN, which is closely correlated with slow release rate of P and K in NPK fertilization. One should also take into account that percentage of nitrogen in NPK fertilizer is smaller (7 %) than in KAN fertilizer (27 %).

By counting the number of clusters it could be determined that fertilization had no influence on clusters number. Each annual shoots had two clusters.

4. CONCLUSIONS

Based on research conducted at the Family Farm "Željko Sameljak" about the impact of mineral fertilization on the growth of shoots of grapevine, the following can be concluded:

- Mineral fertilization with KAN as nitrogen fertilizer gave the highest average growth of shoots during the growing season,

leaves mass and length of the shoot. Influence of NPK fertilization on growth and length of shoots, number of nods, leaves and number of clusters on a shoot did not show the predicted better results than the Control. In order to clarify these effects further studies are suggested and strongly encouraged.

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Mycogona perniciosa attacker Agaricus bisporus

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Abstract

The cultivation of mushrooms is an art, and we must give them the best care we can to get the highest yields. Diseases and pests often happen by themselves. A grower's job is to keep them from happening. Fungicides, insecticides and other chemicals may help, but prevention is worth 16 times as much as a cure. Every precaution should be taken to prevent disease occurring. Mushrooms are subject to several diseases, one of the worst being caused by a fungus known as *Mycogona perniciosa*. This parasite spreads quickly, and causes the wet bubble, malformation, white, fluffy mycelia growth and amber droplets. It can cause serious yield damage if not threat well.

Keywords: Mycogona perniciosa; Agaricus bisporu;, disease.

1. INTRODUCTION

The mushroom is a form of plant life known as a fungus (plural, fungi) [1]. *Agaricus bisporus* is more commonly known as the white or button mushroom. Cultivating the edible mushroom, *A. bisporus* is a highly specialized process, aimed at producing the maximum yield of perfectly formed mushrooms [2]. The mass production of *Agaricus bisporus*, known as the button mushroom started in the first half of the 20th century. The first book describing cultivation of mushrooms was written by De Tournefort in 1707, and in 1754 the first specialized building for mushroom growing was described [3]. Compost for cultivation of *Agaricus bisporus* is prepared from a mixture of organic materials subjected to a composting process for making it selective for the mushroom [2] . Main components in button mushrooms production are the mushroom production compost and the 5 cm thick casing soil layer that covers compost. Mushroom compost is made of wheat straw, chicken manure and gypsum, that is inoculated by button mushrooms mycelium. Nitrogenous substances and calcium sulphate are added to ensure a selective substrate for optimal development of the mushrooms [2]. Composting consists of two distinct phases i.e. phase I and phase II [5]. The aim of phase I is to adjust the total nitrogen to between 1.8 and 2% and the moisture content to 75% [3]. Phase I composting lasts from 7 to 14 days, depending on the nature and characteristics of the material at the start [6]. There are two major purposes of phase II composting; the first is pasteurization to kill insects, nematodes and other pests that may be present, the second is to lower the ammonia concentration formed during phase I to levels that are not inhibitory to mushroom spawn growth [6]. Mushrooms will not grow in colonized compost alone. After colonization of *Agaricus mycelia* in the substrate is complete, a 1.5-inch layer called casing, consisting of peat soil amended with calcium carbonate or lime residue (a by-product from the sugar industry), to neutralize pH and water (about 80 percent moisture), is applied on top of the compost bed. This layer is called the casing soil [7]. The casing soil is critical and must be free of pathogenic bacteria, have the correct structure, an acidity degree of pH 7.5, and be capable of retaining a lot of water. The bacteria that live in the casing soil stimulate the mycelium to produce the mushrooms. Without these bacteria, no mushrooms would grow, therefore good casing soil is imperative to mushroom cultivation. Casing layer is one of the most important components of *Agaricus spp* production and it directly affects mushroom productivity, size and mass [8]. Like all other crops, mushrooms are also affected adversely by a large number of biotic and abiotic agents/ factors. Fungi are the most important group of pathogens of the mushroom, occurring wherever the crop is grown [5]. The management of fungal diseases of mushrooms poses problems, because both the host and pathogen are fungi [8]. A number of harmful fungi are encountered in compost and casing soil during the cultivation of white button mushroom. Fungal diseases include cobweb, green mould, mat and confetti, yellow mould, truffle, dry bubble, wet bubble, shaggy stipe, gill mildew and cap spotting. Many of these act as competitor moulds thereby adversely affecting spawn run whereas others attack the fruit bodies at various stages of crop growth producing distinct disease symptoms. At times there is complete crop failure depending upon the stage of infection, quality of compost and environmental conditions [9]. The drastic changes in the shape of mushrooms infected with *M. perniciosa* including wet bubble, malformation, white, fluffy mycelia growth and amber droplets [10] have been investigated since the 1900s [11]. The word *Mycogona* is of Greek origin: Myco – "mushroom of fungus", and the suffix "gone" means reproductive body [12]. This mushroom disease has a few often used names: «Mycogone», «Wet bubble», «white mould», «vesicular disease». *Mycogona perniciosa*, which causes Wet Bubble Disease of Agaricus bisporus, is very contagious and results in severe crop losses [13]. The disease, wet bubble, is caused by *Mycogone perniciosa* Magn. and the perfect stage is *Hypomyces perniciosa*. Mycelium of the pathogen is white, compact, feltlike. *Mycogone perniciosa* forms two kinds of spores conidiospores (unicellular, thin-walled spores, with a relatively short life, very light, therefore, they can be carried by wind) and chlamydospores (consist of two cells, thick-walled, brown spores, that life for several years) Hyphae branched interwoven, septate, hyaline, 3.5m broad. Conidiophores short, slender, branched, hyaline measuring 200 x3-5m and having sub-verticillate to verticillate branches which bear thin walled, one-celled conidia measuring 5-10 x 4-5m. Large two-celled chlamydospores present; upper cell warty, thick walled, globose, bright coloured measuring 15-30 x 10-20m, lower cell hyaline, smooth and measure 5-10 x 4-5m. Mushrooms with wet bubble disease are very misshapen and not fit for sale [14]. Sharma and Kumar (2000) reported all the strains of *A. bisporus* (U-3, S-11, 791, S-910) and *A. bitorquis* (NCB- 6, NCB-13) susceptible to *M. perniciosa* under in vivo conditions [9]. *Agaricus bisporus*, will take several weeks to grow fruiting bodies and at that time there is great possibility to be infected with Mycogona perniciosa. Mushrooms that have been affected by the disease on an early stage turn into a shapeless mass, covered with the parasite's white and fluffy mycelium. As the deformed mushroom develops, it becomes brown and starts to decay. Due to the watery decaying and the shape of affected mushrooms, this disease got the name «Wet bubble». Moreover, little droplets of liquid amber in color appear on the surface of mushroom tissue, especially at a very high level of humidity. On this stage, the mushroom begins to rot and that is accompanied by a objectionable odor. Under dryer conditions, the deformed mushrooms can have hideous offshoots, but their tissue will remain dry, like with the Verticillium disease (dry bubble or fungus spot) [12]. Hsu and Han (1981) reported that the infected sporophores may be recognised by two symptoms, one is tumorous form, infected from pinheads, and other is malformation, infected at later stage [15]. Both types of infections may exude water drops on the surface of infected sporophores. These water drops later change into amber colour. Sharma and Kumar (2000) described the symptoms as short, curly, pure white fluffy mouldy growth of the pathogen on malformed mushrooms, which can be easily observed by nacked eyes [9]. Umar et al., (2000) described dramatic cytological changes as a result of infection when young (up to 6mm) pin heads were infected [13]. Large, very irregular, nodular and tumorous fungal masses are formed and no differentiation or organogenesis of the cell mass takes place. Mycopathogen grew on the surface as fluffy mycelium but was absent deep on the lesions. Transmission EM revealed two kinds of cell wall reactions, either focal swelling like cushion at the site of adhesion of *M. perniciosa* or focal lytic changes with swollen mitochondria.

2. CONCLUSIONS

Spread of *M. perniciosa* occurs primarily through casing soil but the introduction of pathogen through other agencies, like spent compost and infected trash, is not ruled out. The infection can be airborne, water borne or may be mechanically carried by mites and flies [17]. The average interval between inoculating casing and symptom appearance found by Hsu and Han (1981) was 13.74 days [15]. The minimum time between inoculation of casing with *M. perniciosa* and symptom development however is eleven days [18]. The average interval between inoculating casing and symptom appearance found by Hsu and Han (1981) was 13.74 days [15]. The minimum time between inoculation of casing with *M. perniciosa* and symptom development however is eleven days [18]. The terminal chlamydospores can remain viable in stored casing for at least three years [10]. Hsu and Han (1981) found that agar discs containing active mycelium and chlamydospores of *M. perniciosa* buried in casing soil and in autoclaved compost show that the fungus survives for 180 days and more than seven months, respectively [15]. Even today *M. perniciosa* has not been eradicated and controlling the pathogen remains a difficult task [19]. Conidiophores and chlamydospores are spread easily when the beds are irrigated. This is why the irrigation should be carried out only after all mushrooms affected with *Mycogone* are removed. All diseased mushrooms can be removed before harvest and the affected areas can be strewed with salt. Due to this, there are fewer chances for the fungus to be spread by pickers through spores and pieces of mycelium on hands and tools. All spent manure should be carted as far, and as soon, as possible from the environment space. Casing soil and environment space should be sterilized by steam to prevent disease. Also there is some chemicals that is recommended to stop disease appearance. The most effective compounds for the control *Mycogona perniciosa* are Sporgon 50 WP based on prochloraz Mn complex. And Mirage 45 EC also based on prochloraz.

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Weather conditions effects on yield of main field crops in Croatia

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Abstract

Weather characteristics considerably influencing factor on field crop yields and yield variation among years. The harvested areas (4-year means 2007-2010) of main spring field crops in Croatia were 299030 ha (maize), 45761 ha (soybean), 25803 ha (sugar beet) and 28256 ha (sunflower). Variation of yields among the years were relative high, especially for maize and soybean, because the lowest yield in 2007 was for 38% (maize) and 35% (soybean) lower than the highest yield realized in 2008. Analogical comparison for remaining two tested field crops was, 26% and 20% for sunflower and sugar beet, respectively. The 2007 growing season was unfavorable for spring crops growing in Croatia because of water shortage and higher air-temperatures. For example, precipitation in April-September period of 2007 in Osijek was 229 mm only or for 40% lower and air-temperature for 1.5 ^{o}C higher than LTM (long-term mean 1961-1990). Water deficit was especially in June and July because of only 60 mm precipitation or for 60% lower and the higher air-temperature for 2.8 ^{o}C in comparison with LTM. At the same time, in western part of the region water shortage was lower (for example Zagreb: 9% and 20% lower precipitation in April-September and June-July periods). Remaining three tested years, especially 2008, were more favorable for spring crops growing in Croatia because of adequate precipitation and temperature regimes.

Keywords: Air-temperatures; Precipitation; Spring crop yields; Croatia.

1. INTRODUCTION

Weather characteristics are main reason for spring field crop yield variations among year. For example, in the decade-period 1998-2007 maize yield, as the most frequently field crop, variation in Croatia (State Bureau for Statistics, 2008) was in range from 3.86 to 6.92 t ha^{-1}and they are mainly resulted by precipitation and temperature regimes [1]. Harvested areas of maize have been distributed mainly in Pannonian region of the country (the Eastern Croatia, Central and Northwester Croatia: total 27580 km^2 participating close to 50% of territory of the country) because only 4% of maize harvested areas situating in remaining part (Mountain and Mediterranean regions) of the country [2]. Kovacevic et al. [3] reported that soybean, sunflower and sugar beet harvested areas covering mainly the eastern Croatia (90%, 98% and 95%, respectively: means 2005-2007) which participating with only 22% in the state territory. Also, the Eastern Croatia participating with 60% in arable land harvested area of Croatia. Majority of wheat growing areas of Croatia (75%) are situated in the Eastern Croatia, while contribution of this region in total barley harvested areas are close to 50% [4] [5]. Aim of this study focused on precipitation and temperature regimes impact (the period 2007-2010) on yields of main spring field crops (maize, soybean, sunflower and sugar beet) in Croatia.

2. METHODS AND MATERIALS USED FOR RESEARCH

For this study, the data from State Hydrometeorological Institute (precipitation and air-temperature) and State Institute for Statistics (statistical yearbooks: harvested area and yield) were used. Total four weather bureaus were used as source of weather data as follows: Osijek and Slavonski Brod representing Eastern Croatia, Bjelovar and Zagreb-Maksimir representing Central and North-western parts of Croatia. Choice of these localities was made based on previously mentioned distribution of tested field crops in Croatia.

3. RESULTS AND ACHIEVEMENTS

The harvested areas (4-year means 2007-2010) of main spring field crops in Croatia were 299838 ha (maize), 45647 ha (soybean), 25596 ha (sugar beet) and 28153 ha (sunflower). Variation of yields among the years were relative high, especially for maize and soybean, because the lowest yield in 2007 was for 38% (maize) and 35% (soybean) lower than the highest yield realized in 2008. Analogical comparison for remaining two tested field crops was, 26% and 20% for sunflower and sugar beet, respectively (Table 1).

Differences of main yields of the field crops among the years could be explained by weather characteristics during individual growing season, especially precipitation and air-temperature regimes [6] [7] [8]. However, there is estimation that intensity of weather characteristics effects in the last few decades period on field crops yield is considerably higher in comparison with the earlier period as result of global climate changes [9]. Despite the complexity of global food supply, here we show that simple measures of growing season temperatures and precipitation explain about30% or more of year-to-year variations in global average yields for the world's six most widely grown crops. For wheat,

Table 1. The harvested areas and yields of spring field crops in Croatia (Statistical Yearbooks 2010 and First Release 2011)

The field crop	The harvested areas (ha) and yields (t ha^{-1}) for 2007-2010 period							
	The harvested area (ha)				Yield (t ha^{-1})			
	2007	2008	2009	2010	2007	2008	2009	2010
Maize	288380	314062	296910	296768	4.94	8.00	7.40	7.00
Soybean	46506	35789	44292	56456	1.95	3.00	2.60	2.70
Sugar beet	34316	22000	23066	23832	46.1	57.7	52.8	52.4
Sunflower	20615	38631	27366	26412	2.63	3.10	3.00	2.30
The other crops	456913	444934	471389	493948	* only in using (under cultivation)			
Arable land (ha)*	846730	855416	863023	897416				

Table 2. Precipitation and air-temperatures in Pannonian region of Croatia

Year	Monthly precipitation (mm) and mean air-temperature (°C) - LTM (average 1961-1990)													
	April		May		June		July		August		September		Σ	X
	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C
	Osijek													
2007	3	13.3	56	18.2	33	22.3	27	23.8	45	22.2	65	14.5	229	19.1
2008	50	12.5	67	18.1	76	21.5	79	21.8	46	21.8	86	15.7	404	18.6
2009	19	14.6	39	18.3	63	19.2	14	23.2	61	22.9	10	19.1	206	19.6
2010	71	12.4	121	16.5	234	20.4	32	23.2	111	21.7	108	15.6	677	18.3
LTM	**54**	**11.3**	**59**	**16.5**	**88**	**19.5**	**65**	**21.1**	**59**	**20.3**	**45**	**16.6**	**370**	**17.6**
	Slavonski Brod													
2007	7	13.3	69	18.2	97	22.3	35	23.2	50	22.4	120	14.1	378	18.9
2008	69	12.6	70	17.5	88	21.4	85	21.8	35	21.5	83	15.0	430	18.3
2009	13	14.2	44	18.1	104	19.3	61	22.6	29	22.3	29	18.7	280	19.2
2010	53	12.3	161	16.2	177	20.2	44	22.7	44	21.8	88	15.3	567	18.1
LTM	**58**	**10.9**	**73**	**15.9**	**86**	**19.0**	**83**	**20.7**	**73**	**19.8**	**62**	**16.1**	**435**	**17.1**
	Bjelovar													
2007	5	14.0	53	18.3	60	22.4	50	23.2	60	21.6	154	14.5	382	19.0
2008	31	12.2	24	17.8	138	21.2	59	21.9	77	21.7	50	15.1	379	18.3
2009	33	14.9	50	18.1	102	19.2	50	22.4	21	22.6	37	18.5	293	19.3
2010	65	12.2	136	16.4	178	20.3	79	23.3	172	20.9	204	14.9	834	18.0
LTM	**63**	**10.8**	**79**	**15.6**	**96**	**18.7**	**78**	**20.4**	**82**	**19.5**	**65**	**15.8**	**463**	**16.8**
	Zagreb-Maksimir													
2007	2	13.7	71	18.2	97	22.2	49	22.9	102	21.3	136	14.5	457	18.8
2008	40	12.0	44	17.4	103	20.9	86	21.9	55	21.4	48	15.6	376	18.2
2009	52	14.5	49	18.4	68	19.8	96	22.3	79	22.6	22	18.9	366	19.4
2010	63	12.0	98	16.6	104	20.4	53	23.2	141	20.8	195	15.1	654	18.0
LTM	**64**	**10.6**	**79**	**15.3**	**100**	**18.5**	**83**	**20.1**	**95**	**19.3**	**79**	**15.8**	**500**	**16.6**

maize and barley, there is a clearly negative response of global yields to increased temperatures [10].

Annual global temperatures have increased by about 0.4 ◦C since 1980, with even larger changes observed in several regions [11]. While many studies have considered the impacts of future climate changes on food production [12] [13] the effects of these past changes on agriculture remain unclear. It is likely that warming has improved yields (food production per unit of land area) in some areas, reduced them in others and had eligible impacts in still others [10]. Our experiences are tendency to negative effects of climate changes on maize yield under conditions of the Eastern Croatia [1][2][3]. Potential impacts of temperature increases may have also been countered by adaptation measures taken by farmers, such as changes in planting dates or use of different cultivars [14][15].

Precipitation and temperature regimes (Table 2) are main responsible factors for the field crop yield differences among years for the 2007-2010. With that regards, the 2007 growing season was unfavourable for spring crops growing in Croatia because of water shortage and higher air-temperatures, especially in July and August (Table 1). Increasing precipitation and decreasing of air-temperature from east to west part of Pannonian region are general trend of climate in Croatia. Comparison of these data for Osijek and Zagreb could be used as a typical example (Table 2). For this reason, drought and high air-temperature stress is more affecting negative factor of yield in the eastern Croatia in comparison with its western part. Additional negative factor in dry years is prevailing of less compacted soils and for this reason difficulty in ascending migration of ground water in soils of the eastern part of Croatia [16] [17].

Drought and high air-temperatures stress was more affected yield loss in the eastern part of Pannonian region in the the 2007 growing season. For example, precipitation in April-September period of 2007 in Osijek was 229 mm only or for 40% lower and air-temperature for 1.5 ^{o}C higher than LTM. Water deficit was especially in June and July because of only 60 mm precipitation or for 60% lower and the higher air-temperature for 2.8 ^{o}C in comparison with LTM (Table 2). At the same time, in western part of the region water shortage was lower (for example Zagreb-Maksimir: 9% and 20% lower precipitation in April-September and June-July periods). Remaining three tested years, especially 2008, were more favorable for spring crops growing in Croatia because of adequate precipitation and temperature regimes.

Improvement of soil properties by hydromelioration and agromeliorations could be also contributes to field crops stabilities among years.

4. CONCLUSIONS

Precipitation quantities and their distribution accompanying with temperature regime have considerable influences on field crops yield under conditions of Croatia. In general, low yields of main spring crops are in close connection with the lower precipitation and the higher air-temperatures, especially during July and August, in comparison with the long-term averages. With that regard, the growing season was especially unfavourable compared to 2008-2010 period.

5. ACKNOWLEDGEMENTS

These investigations have been supported by Ministry of Science, Education and Sport in Zagreb (the project 079-0730463-0447).

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Correlation analysis for yield and some morpho-physiological indicators of maize leaf

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Abstract

The research has been set up as split-split plot method in three repetitions at trial fields of Agricultural institute in Osijek during growing season 2009. Irrigation is main factor: A1 = control, A2 = 60-100% field water capacity (FWC), and A3 = 80-100% FWC. N fertilization was applied as follows: B1 = control, B2 = 100 kg N ha^{-1} and B3 = 200 kg N ha^{-1}. Two maize hybrids (OSSK 596 and OSSK 617, FAO 500 and FAO 600) have been tested. Analysis of variance showed statistically very significant impact of hybrid on specific leaf area, specific leaf weight and leaf water content. Significant morphological and physiological indicators have been used for determination of correlation analysis between yield and indicators.

Keywords: Maize hybrids; Specific leaf area (SLA); Specific leaf weight (SLW); Leaf water content (LWC); Yield; Correlation analysis.

1. INTRODUCTION

Maize (Zea mays L.) is one of the most important cereals in Croatia. According to Central bureau of statistics [1] maize harvested area in year 2008 was 314 062 ha with average yield of 8 t/ha, while year later (2009) harvested area was reduced for 5.77% (296 910 ha) with lower yield for 8.1% (7.4 t ha^{-1}). Maize harvested area in year 2010 was 296 768 ha with yield of 7 t ha^{-1}.

According to several authors [2], [3], [4] available amount of water and nitrogen (N) fertilizer are two main factors for achieving high yield of maize grain. There is positive correlation between agricultural measurements, irrigation and nitrogen fertilization with some photosynthesis intensity factors: leaf area (LA), specific leaf area (SLA), specific leaf weight (SLW), leaf water content (LW), and chlorophyll content [5]. Yield of maize grain is strongly correlated to leaf area [6]. According to Foutz et al. [9] dry matter production of a single plant must be correlated with the production of leaf area and photosynthetic rate.

Knowledge of interrelationship between grain yield and its contributing components improves the efficiency of breeding programs through the use of appropriate selection indices [7].

According to Wannows et al. [8] yield of corn (*Zea mays* L.) is considered as a complex inherited character therefore, direct selection for yield per se may not be the most efficient method for its improvement, but indirect selection for other yield related characters, which are closely associated with yield and high heritability estimates will be more effective.

Maize yield is highly correlated with total leaf area on the plant which intercepted solar radiation for photosynthesis [10].

Aim of this study is to evaluate the correlation strength between yield of maize grain and some morphological and physiological indicators while the results for yield (Y) are presented by Josipović et al. [2], while leaf area (LA), specific leaf area (SLA), specific leaf weight (SLW), leaf water content (LW), and chlorophyll content data where presented by Marković et al. [5].

2. METHODS AND MATERIALS USED FOR RESEARCH

The research was set up at the Agricultural institute in Osijek during vegetation season of 2009. Trial has been set up as split-split plot method in three repetitions. Soil type on trial fields is eutric cambisol. Main treatment includes three irrigation regimes and it was conducted as follows: A1 - control variant without applied irrigation, A2 variant – soil water content was kept from 60% to 100% field water capacity (FWC), and A3 variant – 80% to 100% FWC. Soil water content has been measured with system of gypsum block which were setup at two depths: 15 cm and 25 cm. Water content has been scanned every second day with Watermark device who works on principal of electrical conductivity. Measured values of soil water content where used for making a decision when to irrigate. Irrigation starts when water content in soil is 60% of field water capacity (FWC) in A2 variant (25. 0%) and 80% FWC (30. 8%) on A3 variant.

Second treatment was nitrogen fertilization, and it was applied as follows: B1 – control variant without applied N fertilizer, B2 – fertilization with 100 kg N ha^{-1}, and B3 – fertilization with 200 kg N ha^{-1}.

Two different hybrids C1 = OSSK 596 and C2 = OSSK 617, created at Agricultural institute in Osijek with similar vegetation length (end of FAO 500 and the beginning of FAO 600 group) have been analyzed. Maize leafs have been removed from three average healthy plants in silking phase. Afterwards the chlorophyll content has been measured with FIELDSCOUT CM 100. Fresh leaf weight was determined with analytical scale. Afterwards leafs where dried at 105 ^{o}C until constant weight, and afterwards weighted again.

Given results have been used to determine the leaf area (LA), specific leaf area (SLA), specific leaf weight (SLW), and leaf water content (LWC). Maize leaf has been scanned and with closed polygons systems leaf area has been measured. Program AutoCAD, Civil3D (2009) is used for technical drawing and measuring of leaf area which is expressed in quadratic meter (m^2). Specific leaf area is measured as follows: leaf area / dry weight (m^2 kg^{-1}). Specific leaf weight is measured as follows: fresh weight / leaf area (g m^2). Leaf water content is measured as follows: (fresh weight – dry weight / fresh leaf weight) x 100.

Given results where statistically analyzed [2], [5] and correlation analysis for yield and tested features (LA, SLA, SLW, leaf water content and relative chlorophyll content - ChlC) has been determined.

Table 1. Correlation analysis for yield of maize grain and some morphological and physiological indicators of photosynthesis activity

** Marked correlation are significant at $p < 0.01$

Variable	Means	Std.Dev	FLW	LA	ChlC	DLW	SLA	SLW	LWC
FLA	18.6	7.387							
LA	0.06	0.004	-0.11						
Chll	290.6	67.28	-0.02	0.13					
DLA	4.23	0.245	-0.26	0.49**	-0.14				
SLA	13.7	0.664	0.23	0.55**	-0.09	-0.29			
SLW	73.2	3.797	-0.21	0.58	0.12	0.25	0.98**		
LWC	74.4	1.440	0.34	0.23	-0.17	-0.41	0.74**	0.73**	
Y	**10754**	**1210**	**0.23**	**0.62****	**0.21**	**0.29**	**0.43**	**-0.42**	**0.05**

FLW – fresh leaf weight; LA – leaf area; ChlC – relative chlorophyll content; DLW – dry leaf weight; SLA – specific leaf area; SLW – specific leaf weight; Y- yield

3. RESULTS AND ACHIEVEMENTS

Correlation analysis for yield of maize grain and tested features (LA, SLW, SLA, leaf water content and chlorophyll relative content) are presented in Table 1.

The result of correlation analysis had shown that yield of maize grain is statistically very significant (** $p<0.01$) and positively correlated with the leaf area of maize (Picture 1), while no significant to other tested variables. The correlation coefficients is 0.62** (Table 1) which indicates to strong correlation between those tested variables.

This result is in accordance to many previously studies. Malik et al. [6] reports in results of their study strong correlation coefficient ($r = 0.69$**) between yield and leaf area of maize. Ahsan et al. [7] reports a strong correlation ($r = 0.627$*) between yield of maize grain and leaf area at genotypic level and medium strong correlation ($r = 0.492$**) at phenotypic level. Wannows et al. [8] reported that there is medium strong correlation ($r = 0.497$**) between yield of maize grain and leaf area index (LAI).

Relative chlorophyll content (ChlC) was not significant correlated to yield of maize grain which is accordance to Foutz et al. [9] who reports that little evidence exist to prove that photosynthetic rates per unit leaf area are correlated with yield of individual genotypes within the same species. Same authors claim that cultivars may have a high potential photosynthetic activity per unit leaf area and yet not produce a high yield because of genetic or environmental factors which would limit utilization of this potential. According to results of their study [9] leaf area per plant is highly correlated ($r=0.90$**) with dry matter production per plant.

Samia and Samiha [10] in results of their study also reports that leaf area was highly correlated with maize plant yield ($r=0.89$).

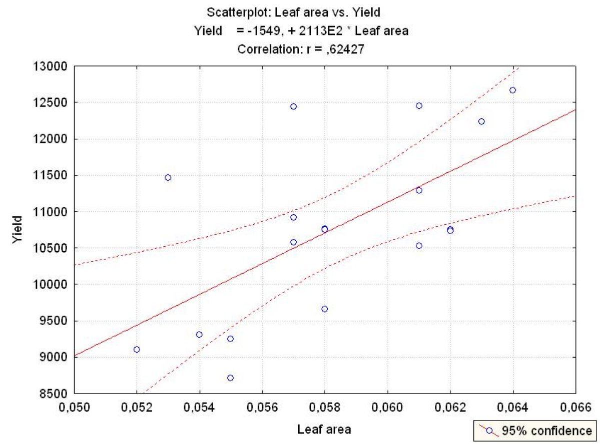

Fig. 1. Correlation graph of leaf area (LA) and yield (Y) of maize grain

4. CONCLUSIONS

According to results of this study it could be concluded that leaf area had significant and positive correlation with yield of maize grain and so represents important character and selection criteria in selection programs that are focused to improvement of maize yield.

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The role of pre-accession funds in the process of Croatian accession to the European Union

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Abstract

Membership in the European Union is a priority of the foreign policy of the Government of the Republic of Croatia. Croatia's integration into the European Union is a major challenge and extensive task because it requires numerous adjustments in the national, political, legal and economic system and in all segments of society. This process is longlasting, however, required, primarily for building a stable, modern, efficient and economically succesfull Republic of Croatia. Before the accession to the European Union, each candidate country has to fulfill the uniform criteria for the membership. In order to complement its pre-accession strategy and to help the candidate countries, European Union established pre-accession funds which provide funding for adaption to EU standards. Pre-accession funds are programms for financial and technical assistance. Funds received from pre-accession funds are non-refundable. This paper represents projects of EU pre-accession funds that Croatia has implemented. Programs that ended: CARDS, PHARE, ISPA and SAPARD. Listed programs were replaced by the IPA program. IPA is a new program and Croatia is the user since 2007. This paper also tries to answer questions about financial value approved Croatia for the impletation of each program, ways in which Croatia realized certain program and how it all influenced on Croatia's development and the further process of association to European Union.

Keywords: Pre-accession funds; Assistance; European Union; Croatia.

1. INTRODUCTION

European Union (EU) is the world's largest economic, political and cultural integration. Accession to the EU requires accepting all rights and obligations of the EU. Republic of Croatia, as small, but stable, democratic, European country, in the world of globalization and changes has an important place and role. Croatia and EU started developing their relations with the international recognition of the Croatia as independent and sovereign country 15th January 1992.

2. PRE-ACCESSION FUNDS IN CROATIA

Pre-accession EU funds are programmes of financial and technical assistance to candidate and potential candidate countries to prepare for the full membership to the European Union. Funds received from pre-accession funds are non-refundable.

Republic of Croatia is eligible to participate in the pre-accesion programs after Croatia was granted the status of candidate country for membership of the EU, in June 2004, apropos by adopting of pre-accession strategy for Croatia in October 2004.

The Central Office for Development Strategy and Coordination of EU Funds (CODEF) is responsible for the coordination of EU funds to the Republic of Croatia and the generation of a national development strategy. It is a central institution in the Croatia for EU funds planning and monitoring.

3. FORMER PRE-ACCESSION FUNDS IN CROATIA

The support of the EU for Croatia started during the war and transition after the armed conflict in early nineties of the 20th century. „From 1991 to 2000 the EU provided to Croatia totalled 381,6 million euros. In the period from 1991 to 1995 the EU provided to Croatia totalled 244,8 million euros focused on crisis management and reconstruction, and between 1996 to 2000 EU assistance was re-focused to support the Croatian government's efforts to reconstruct a private and public infrastructure, as well as community life, by promoting respect for human rights and reconciliation."[1] In 2000 the EU offered a new programme of assistance to Croatia, called CARDS.

3.1. CARDS

The CARDS is the programme of technical and financial assistance of the EU. Principal objective is to provide support to South-East European countries for active participation in the Stabilisation and Association Process. Croatia has been beneficiary of the national component CARDS since 2001 until she received the status of candidate country 2004 and it has been beneficiary of the regional component in the period from 2001 to 2006. "In the period from 2000 to 2004 EU approved to Croatia under the CARDS programme 113 projects with total budget of 262 million euros from the national component and 179,6 million euros from the regional component." [2]

By the end of 2006 three funds were avaliable to the candidate countries – PHARE, ISPA i SAPARD, but at the beginning of the 2007 they were replaced with a new programme IPA.

3.2. PHARE

The PHARE is the programme of the pre-accession instrument financed by EU. PHARE's objectives are focused on institution building required in the process of European integration and financing investments in the candidate countries for EU membership and to prepare for future use of the structural and cohesion fund following accession.

The Republic of Croatia has been beneficiary of the PHARE since 2005. „In the period from 2005 to 2006 EU approved financing for a total 43 projects and Croatia received a total of 167 milion euros. (87 million euros for 2005 and 80 million euros for 2006"[3]

3.3. ISPA

The ISPA is the programme of the pre-accession instrument financed by EU. ISPA is aimed for the financing infrastructure projects in the field of transport and environmental protection. From these programs is possible to finance infrastructure projects that enable convergence of the candidate countries with the EU environmental standards and to improve the existing trans-European networks.

The Republic of Croatia has been beneficiary since 2005. „In the period 2005-2006 under the ISPA programme, 60 million euros was allocated to Croatia (25 million euros for 2005 and 35 million euros for 2006)."[4] This refers to implementation of 2 infrastructure projects in the field of environmental protection, 1 infrastructure projects in the field of transport and 3 projects of technical assistance.

3.4. SAPARD

The SAPARD is the programme of the pre-accession instrument financed by EU. It is intended to agriculture and rural development. Its principal objective is to provide support to candidate and potential countries in solving problems of structural adjustment in their agricultural sectors and rural areas, and to support in implementing of the EU acquis communautarie in the field of the common agricultural policy. Upon completion of the investment allocation is 50% of the grant of the EU.

Croatia has been beneficiary since 2006. In the 2006 Croatia received 25 million euros. During this programme, there are conducted 4 competition for the allocation of funds. EU approved financing for a total 37 projects. „Total budget of received funds is 250 million euros. Program was replaced in 2009 with a new program called IPARD." [5]

Contracting for programmes CARDS, PHARE i SAPARD has been completed. Programme ISPA is in its final phase. The allocated funds were successfully used that shows the contracting rate for individual programs that exceeds 90%. 256,3 million euros (88,40%) has been contracted of the total budget of 289,9 million euros.

4. IPA

The IPA is the new EU's financial instrument for the pre-accession process. The previous EU instruments for pre-accession have been replaced by IPA since 2007. The main goals of the IPA programme are providing assistance to candidate and potential candidate countries in harmonization and implementation of the EU acquis communautaire and preparation for the participation and utilization of structural funds and cohesion funds after the accession to the EU.

4.1. Utilization of the IPA programme

Assistance in transition and institution building supports activities relating to the adoption and implementation of the acquis communautaire and provides impetus to economic and social cohesion. In the period 2007-2010 it has been achieved very good score of 92,22% of the contracted funds, it is contracted 36,8 million euros of the 39, 9 million euros.

The deadline for contracting of component I has expired, while the others components in the IPA contracting is in progress and contracted percentages are continully increases.

Table 1. EU financial assistance under IPA in 2007.–2012. in millions euros

Country	2007.	2008.	2009.	2010.	2011.	2012.
Turkey	497.2	538.7	566.4	653.7	781.9	899.5
Serbia	189.7	190.9	194.8	198.7	202.7	206.8
Croatia	141.2	146.0	151.2	154.2	157.2	160.4
Kosovo	68.3	184.7	106.1	67.3	68.7	70.0
Bosnia and Herzegovina	62.1	74.8	89.1	106.0	108.1	110.2
Macedonia	58.5	70.2	81.8	92.3	98.7	105.8
Albania	61.0	70.7	81.2	93.2	95.0	96.9
Montenegro	31.4	32.6	33.3	34.0	34.7	35.4

Source: made by authors using http://ec.europa.eu/enlargement/pdf/publication/ipa_brochure_2009_en.pdf 16.06.2011.

Table 2. EU financial assistance in Croatia under IPA in 2007.–2012. in millions euros

IPA components	2007.	2008.	2009.	2010.	2011.	2012.
Transition Assistance and Institution Building	49.6	45.4	45.6	39.5	39.9	40.9
Cross-border Co-operation	9.7	14.7	15.9	16.2	16.5	16.9
Regional Development	45.0	47.6	49.7	56.8	58.2	59.3
Human Resources Development	11.4	12.7	14.2	15.7	16.0	16.0
Rural Development	25.5	25.6	25.8	26.0	26.5	27.3
TOTAL	141.2	146.0	151.2	154.2	157.1	160.4

Source: http://www.hbor.hr/Default.aspx?sec=1628

Table 1 shows financial assistance under IPA for all candidate and potential candidate countries. As can be seen from the table 1 European Commission has earmarked for the IPA implementation for Croatia the total amount of 910,2 million euros. The largest amount received Turkey (3.937.4 million euros), and the lowest Kosovo (201.4 million euros).

IPA contains five components. Croatia has been beneficiary since 2007 until its accession to EU. „The financial value of the IPA programme for the five-year period is the total amount of 910,2 million euros as shown in table 2.“[6] Listed below are individual components and achieved results of each component for the period 2007 to 2010.

In the Cross Border and Regional Cooperation, Croatia participates in three cross-border programmes with the EU member countries(Slovenia, Hungary, Italy), three cross-border programmes with potential candidate countries(Bosnia and Herzegovina, Montenegro, Serbia) and in transnational programmes (Mediterranean and Southeast Europe). Croatia has signed the financing agreements for cross-border programmes with the potential candidate countries for 2007 and 2008, in a total amount of 5,3 million euros. From these funds are financed 43 projects with partners from the region. Agreements on cross-border cooperation and participation in transnational programmes total amount is 2,8 million euros. Cross-Border Cooperation Programme Croatia-Serbia is total 800 tousand euros, Croatia-Bosnia and Herzegovina is total 1 million euros, Croatia-Montenegro 400 tousand euros, while participation in transnational programmes is 659 tousand euros. So far utilization of these programmes is larger than 90 % of the reserved funds.

Regional Development supports infrastructure projects in the environmental protection and transport sectors, as well as programmes aimed at promoting regional competitiveness. It is implemented through the three operational programmes: 1. Operational Programme for Transport supports infrastructure projects in the field of transport. The prioritiy in Croatia is the upgrading of railway system through upgrading and modernisation of railway line and upgrading of waterways and harbour infrastructure. Zagreb Main Station Signalling and Interlocking System is the first infrastructere projects (value11,6 million euros) with the rate of 17,72% in relation to the allocation 2007-2009. 2. Operational Programme for Environmental Protection supports infrastructure projects in environmental protection sector with emphasis on the development of infrastructure for waste management for the purpose of establishing an overall system of waste management in Croatia and on the protection of water resources of Croatia through the upgrading of water supply system and integrated system of waste water management. There are conctrated projects of water supply and drainage: Slavonski brod (27,3 million euros), Drniš (6,4 million euros), Knin (16,6 million euros). The percentage is 29,29% % in relation to the allocation 2007-2009. „Projects in implementing are: County Waste Management Centre Kaštijun(75,42 million euros of which the IPA is 18,95 million euros) and Marišćina (101,62 million euros of which the IPA is 22,33 million euros).“[7] 3. Operational Programme for Regional Competitiveness encourages the upgrading of developmental potential of less developed regions in Croatia and strengthen the competitiveness of the Croatian economy. Contracted rate is 44,68%.

Human Resources Development finances activities directed to the promotion of employment, education and social inclusion. The priorities is to relate the improvement of access to employment and sustainable inclusion in the labour market, strengthening of social inclusion of persons with difficult access to the labour market, advancment of human capital and employability. It is contracted totally 53 projects, apropos 71,17% of funds for period 2007-2009.

Rural Development- IPARD programme provides financial means for projects in the field of agriculture and those promoting the development in rural areas. For the period 2007–2011 it is provided 129,40 million euros. So far, it is conducted 6 competition. Here is the lowest conctrating percentage of 9,97%. It is contracted 44 projects (in the first 3 competition value of 10,26 million euros).

Croatia closed the accession negotiations with EU on 30 June 2011. IPA will be implemented until Croatia's accession to EU and that is foreseen for 1 July 2013.

5. Conclusion

Croatia has in recent years and until now poorly used the pre-accession funds. Resources could be used more effectively and more utilized. Croatia has to increase the number of projects, learn on former projects and to invest major efforts to make full use of all the advantages of EU funds in order cohesian funds gave positive results in the future. However, implemented projects with their goals and results still helped Croatia on its way to accession to EU. In the implementation of the projects were included many enterprises, local and regional goverments who affected the overall level of employment and also had an impact on the daily life of citizen of Croatia.

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The role of Business Angels in financing of small sized enterprises in Croatia

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Abstract

The financial crisis has spread worldwide and caused the global economic crisis. Reduced loan leads on one side results with reduction of production sector, on the other side it results with decreased demand. Global economic crises largely declined small business activities in the past few years. Small businesses are the largest employers, suppliers and business innovators. They can not to fund their activities by themselves, and therefore have reduced number of employees, and many will be liquidated. Government, banks, investment funds, strategic partners, capital markets and the rich individuals may be saviors of these companies. Important role in such situations have business angels. Business angels fill the gap between founders, family, and friends on one side, and institutional venture capital funds on the other side, as a financing source. Business angels invest a large amount of money in seed, start-up, and early-stage enterprises. Private individuals have always had a tendency to invest in high-risk projects. Business angels are important for small enterprises because they provide more than money. They are hands-on investors and contribute their skills, expertise, knowledge, and contacts in the businesses they invest in. They are wealthy persons with great business experience, willing to invest and offer their wealth and knowledge to owners and to entrepreneurs to start or develop their businesses.
There are only about twenty business angels in Croatia. They fill a huge hole from idea to its realization that entrepreneurs are heavily substituted. Before, the only solution for entrepreneurs was a multi-year savings to provide enough money to attempt to realize their ideas. Business angels funding significantly increases the chances of success and benefit of businesses and the entire society.

Keywords: Business angels; Small-sized enterprises; New ventures; Investment; Entrepreneur.

1. INTRODUCTION

The term “business angels” has its origin in Broadway plays. Several decades ago, those who funded this form of entertainment were referred to as angels. William Wetzel is credited with first applying the term to business, where the financing of early-stage enterprises can feel like “money from heaven” for entrepreneurs. Angel investments do not just fall from the sky, unencumbered; they are not gifts. These investments come with terms, requirements, and an investor[1].

One famous example of entrepreneurs raising capital from private investors is the decision by Queen Isabella of Spain to finance the voyage of Christopher Columbus – a highly profitable investment for the Spanish. Just to illustrate: in 1874, Alexander Graham Bell used funds from business angels to found Bell Telephone; in 1903, five business angels helped Henry Ford, with $40,000; in 1977, a business angel invested $91,000 in Apple Computers[2].

2. CHARACTERISTICS OF BUSINESS ANGELS

Population of business angels is quite diverse, their profile is not difficult to describe. In almost all research on business angels, the same or similar demographic features emerge [3].

It is no longer a question of whether angels are viable capital resource for early-stage ventures. Angels are a source—in fact, the primary source—of capital, worth the entrepreneur’s time, energy, and financial resources to seek and access; they should be considered before other alternative, nontraditional capital resources.

Table 1. Characteristic of business angels

Characteristic	Description
Gender	Studies conducted in various countries confirm that most business angels are male
Age	Business angels are generally from 40 to 65 years old
Education	Business angels are typically people with a university diploma and/or professional qualifications, but angels with masters and doctorates are rare.
Occupation	Business angels come from various professional fields
Wealth	This is one of the main preconditions of becoming a business angel. Business angels invest an average of £10,000 per deal and generally have a portfolio of two to five investments.
Investing personal assets	The fact that business angels invest personal assets distinguishes them from institutional investors of high-risk capital, whose funds come from sources such as pension funds, banks, university endowments, and insurance companies that have legal obligations to exercise caution and invest in less risky ventures.
They make risky decisions	They are ready to make different decisions, which often carry a large dose of risk.
They invest locally	Business angels prefer to invest in enterprises near their homes.
Investing in unquoted companies	Business angels invest in companies that are not quoted in the stock market.

3. BUSINESS ANGELS AS THE BEST SOURCES OF CAPITAL

For the early-stage venture, venture capitalists impose rigid criteria, leaving numerous companies unable to qualify. Thus, as venture capital is the real contributor to later-stage deals, angel capital has become the indubitable contributor to early-stage deals, the resource for the majority of companies. The primary source of capital is the direct, private investor—even though these angel investors possess an inimitable advantage: they do not have to invest[4].

Angel investors have one essential and primary goal identical to venture capitalists—they are in the business of making money. Angels invest with anticipation of a healthy return on their investment. They tend to have among the most lucrative returns, which match the high level of risk they take for providing the earliest professional investment dollars in a company.

Angels have an expectation of financial return just like any other investor. But they also have many attributes invaluable to young companies that can set them apart from other types of investors.

Angels typically: have a sense of social responsibility and enjoy community involvement, take a role in the entrepreneurial process, act as mentors and advisers to the entrepreneur, provide early-stage investment dollars, invest regionally, invest smaller amounts at a time, invest their own money, are able to tolerate the loss of their entire investment, have a diversified portfolio, take a long-term view of their investments—which are often referred to as "patient money."

4. THE INVESTMENT PROCESS

From the time you first meet a prospective angel investor to the time you put that big check in your bank account, it seems like an endless series of interviews, requirements, hoops to jump through, discussions, and document reviews. The entire process can seem like a complete disruption to your business, dragging you away from the things you need to do to earn money.

Angels are in the business to make money. So consider how you would approach investing in a company if you had no prior relationship with the founder.

The investment process includes numerous steps and varies from investor to investor. Although each potential investment takes its own course, if you are prepared for any possible request, you will make the process move smoothly and generally impress your prospective investor. These are the steps the investment process generally follows: get a referral to investor, make initial contact with prospective investor, send executive summary, make the follow-up call and set a first meeting date, do your presentation for potential investor, allow investor to review your business plan, draft term sheet, go through due diligence process, validate business and technology, agree on final term sheet—parallel with due diligence, prepare or approve final documents reflecting term sheet, close the deal, accept investment—often in traunches based on milestones.

A good entrepreneur must know the operating plan and the financial plan. A good manager has a deep appreciation of accounting. Managers know that, without accurate and timely information, a manager cannot manage a company. This sounds obvious, but many entrepreneurs are “concept people.” An entrepreneur who lives by the numbers is the one you want to back[5].

5. BUSINESS ANGLES IN REPUBLIC OF CROATIA

The most popular business angel in the world is Ron Conway, an angel who carries the title for 15 years. Has invested in more than 500 projects, the most famous companies in its portfolio are: Google, Ask Jeeves, Paypal, Good Technology, Opsware and Brightmail.

Another famous angel Peter Andreas Thiel, one of the founders of PayPal. He invested in 2004 more than $ 500,000 in Facebook, which he then ensuring 10.2 percent ownership in the world's largest social network. Today, Thiel has three percent of the company on Facebook, a member of the administration, and its share is worth about $ 1.5 billion. Thiel has invested in LinkedIn, the world's most famous corporate network, as well as other numerous Internet startup projects - Friendster, Rapleaf, Geni.com, Clickable Inc., Yammer, Yelp, Inc[6].

Concept, meaning, impact and funding of business angel is not as well known in Croatia. In Western countries, especially in the U.S., creative business ideas find their way to their realization. Young entrepreneurs need a source of capital, but also investors looking to find a good venture project in which they can invest their money and realize high profit rates on invested capital.

Croatia is not sufficiently established practice of investing; there are not enough private investors who are aware of the benefits that are offered by investing in new projects. Concept of business angels is also unknown the Republic of Croatia. The first step is establishment of the Croatian network of angel-CRANE. It is consisted of several investors who are willing to and who already invested their capital in a few new entrepreneurial ventures.

The best-known business angel in Croatia is Hrvoje Prpic (Management Consultant HGspot and one of the 20 business angels in Croatia) who first invested in the project offSpace. The largest number of investments so far achieved Saša Cvetojević, who invested in four projects more than 200 000 Euros.

5.1. CRANE

CRANE (Croatian Angel Network) is a Croatian network of business angels and private investors interested in investing in productive and innovative companies in the very early stages of development.

Croatian Business Angels Network (CRANE) is a non-profit organization that brings together business angels from the Croatian and abroad who have an interest to invest in innovative projects. CRANE has launched a joint initiative of partner institutions, the Agency for Export and Investment Promotion, Croatian Private Equity and Venture Capital Association, Association for the promotion of software and online businesses 'Initium' and successful businessman Damir Sabol and Hrvoje Prpic.

CRANE business angels networks informal individual investors who provide:

- know-how (technical and business knowledge, knowledge of specific industries, business contacts, etc.).
- investing in a range from 25,000 to 250,000 Euros (more investors - a syndicated investment).

CRANE goals are:

- Encouraging the development of innovative entrepreneurship in Croatia
- Providing assistance to entrepreneurs in the implementation of innovative projects with international potential
- Providing assistance to business angels in the detection, selection and implementation of interesting projects [7].

Small and medium enterprises are the engines of the Croatian economy:

- make up 99.4% of all registered businesses
- employing 64.7% of all employees,
- generate 44% of GDP and 40.5% of exports.

On the other hand, small and medium businesses are faced with the problem of covering the lack of capital, especially in start-up phase, since the banks require collateral, and venture capital investments more difficult at a later, less risky stage business.

Business Angels Network will play an active role in providing capital for the initial phases of projects where there is an evident lack of capital as an alternative placements by other means of financing and thus promote the development of entrepreneurship

Business angels are not 'SOS Fund "for companies that are in trouble, as well as for big expansion. Being a business angel means that in some way enter into the history of the Croatian financial markets because they create something that will make an important stake in the Croatian economy for 15-20 years[8]. Through CRANE was invested in seven projects amount of more than 600,000 Euros.

6. CONCLUSION

Success is about wise investments. A person can invest time, talent and/or money, with the intention to increase future performance, income or assets. Other than inheritance, the only way to create wealth is to invest.

By focusing on the actual investment activity, the researchers can avoid the problem of defining informal investors according to some general characteristics and investment behavior and instead focus on the nature of individual investments.

The private sector not only represents by far the largest portion of the economy, but also promises more rewards for investments. That is also where Angel Investors, Venture Capital and Private Equity firms can contribute the most.

Angel investors are becoming more sophisticated in their investment processes. They take the job of investing seriously and follow procedures established by professional venture capitalists. Angel groups are forming at a rapid rate, reflecting the value of collective due diligence, broad deal access, and the pursuit of mutual interests. Even though most angels still invest on their own, their general level of expectation from the entrepreneur and management team has risen significantly; you must be prepared. Even with the growth of the angel investor population, they remain elusive beasts. Finding the right angel investor is now easier because of angel organizations and possibly other services such as online matching sites.

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An Analysis of the Representation of Certain Types of Traffic of the Traffic System of the Republic of Croatia

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Abstract

The traffic system is one of the most important economic system of every country. The economic and social activities cannot be developed without the traffic system. So, the traffic presents the relations among people, the economic category, the transportation and all operations related to the traffic of goods, passengers and communications. The traffic could not be carried out without the elements required for the production of the transport services. There are three basic elements: means of work, objects of work and work as an intellectual capital.

Considering that the traffic is possible to divide according to many characteristics, in this work will be discussed the traffic division according to medium that is used. According to traffic division, there are few types of traffic: water traffic, land traffic, air traffic, traffic of the telecommunication and space traffic. Each of them will be described separately. It will be given the latest data of the representation of certain transport of the entire traffic of the Republic of Croatia. It will be also presented trends of grow and trends of decline of transported passengers and/or transported certain types of goods.

Keywords: Traffic system; Traffic; Production elements of transport services; Road traffic; Rail traffic; Water traffic; Air traffic.

1. INTRODUCTION

The traffic system is one of the most important economic system of every country. It represents the blood circulation of the economic organism. The economic and social activities cannot be developed without traffic system. Development of a traffic system depends on the degree of development of its technical, technological, organizational, economic and legal strata.

Considering that the traffic is possible to divide according to many characteristics, in this work will be discussed the traffic division according to medium that is used. According to traffic division, there are a few types of traffic: water traffic, land traffic, air traffic, traffic of the telecommunication and space traffic. Each of them will be described separately. It will be given the latest data of the representation of certain transport of the entire traffic of the Republic of Croatia. It will be also presented trends of increase and trends of decrease of carried passengers and/or carried certain types of goods in the period from 2005 to 2009 in the Republic of Croatia.

2. THE TRAFFIC

At the beginning of the detailed elaboration of the topic, it is important to introduce basic concepts related to traffic. It should be noted that the traffic and the transport do not have the same meaning. The transport is a narrower concept than traffic. „Transport is a conveying of passengers or goods over a given distance, that is, from a place of embarking/loading to a place of disembarking/unloading.“[1] It is a specialized activity that uses transport superstructure and infrastructure to enable production of transport services and to handle organized with the spatial and weather distances. The traffic is a broader concept than transport because it represents relationships among people, the economic - financial category and includes transport and all operations related to the traffic of goods, passengers and communication.

Certain elements of production of transport services are required to make transport system work. These elements are means of work, work objects and work as an intellectual capital. The means of work are classified into two groups: 1. transport infrastructure consists of the fixed traffic ways, objects and equipment necessary for transport, 2. transport superstructure consists of transport and loading means which uses the traffic infrastructure crucial enable the production of traffic services. Work objects are all objects that can be transported, transferred, moved from one place to another using the transport infrastructure and superstructure (of all transport sectors). The work as an intellectual capital is only that work that was placed on the transport market. „ A quality work is a basic assumption and the most important factor in the production of transport services that most directly and most intense effects on safety, speed and cost manipulation and transport of freight (and passenger).“[2, p. 102]

3. THE TRAFFIC DIVISION ACCORDING TO MEDIUM THAT IS USED

According to medium that is used consist of a few types of traffic: water traffic, land traffic, air traffic, traffic of the telecommunication and space traffic. Each of these types has its uniqueness.

3.1. Water Traffic

Water traffic is the traffic that uses water as a basic medium. The most important types of water traffic are maritime, river, lake and canal traffic. The common characteristics of maritime, river and lake traffic are that all take place on the water (independently whether the sea, rivers, or lakes), that these routes are natural and without charge, and that they require the artificially constructed beginning and ending points (harbors, piers). The canal traffic is different than the others by the fact that it takes place at an artificial canal.

The following table shows the number of passengers and amount of goods carried by water traffic.

Table 1 shows that the minimum number of passengers carried in maritime traffic and coastal transport was in 2005, while the highest was in 2008, that is increased by 12,42% as compared to 2005. But, it decreased by 2,42% in 2009 compared to previous year.

Table 1. Water transport

	Maritime and coastal transport of passengers and goods		Transport of goods in inland waterways
	Passengers carried, '000	Goods carried, '000 t	Goods carried, '000 t
2005.	11 440	29 975	1 446
2006.	12 079	31 423	1 509
2007.	12 723	32 420	1 468
2008.	12 861	30 768	6 415
2009.	12 550	31 371	5 381

Source: made by authors, using www.dzs.hr

This table shows that the carried amount of goods was the lowest in 2005, while in 2007 was the highest, and that was a 8,16% increase compared to 2005. The next two years have registered the minor fall.

The amount of goods carried in inland waterways has registered a rapid increase in 2008, and it was an increase of 336,99% as compared to previous year.

3.2. Land Traffic

The basic media of the land traffic are different land roadways, as a specific transport infrastructure that determines the specific transport superstructure. The most important types of this traffic are rail, road, pipeline, municipal traffic as well as taxi traffic.

The railway traffic takes place only at the artificial constructed ways (the railway sidings or rails), and uses specially constructed tractional vehicles suitable for transport only on the rail network with a specified width.

The road traffic takes place at the artificial constructed different roads and paths types, and even outside of them, with different types of vehicles (motor, electric and horse-drawn vehicles, bicycles and by foot).

The pipeline traffic takes place at the artificial constructed pipes. They are used for transferring oil, water, gas, coal, etc. It requires constructed beginning and ending points (terminals).

The urban traffic takes place in the areas of density inhabited areas, most often cities. It consist of the road and rail infrastructure and superstructure. It can also be the water traffic.

The taxi traffic is the special type of public road, land traffic that characterizes the transport of passengers organized by cars and mini buses. It can also be river, canal and water traffic.

The following table shows the number of passengers and amount of goods carried by land traffic.

Table 2. Land traffic

	Railway transport		Road transport		Pipeline transport	Urban transport	
						Trams	Buses
	Passengers carried, '000	Goods carried, '000 t	Passengers carried, '000	Goods carried, '000 t	Oil and gas transported, '000 t	Passengers carried, '000	Passengers carried, '000
2005.	39 842	14 333	64 859	58 886	9 396	177 722	185 212
2006.	46 212	15 395	63 576	63 840	8 644	186 591	190 022
2007.	63 131	15 764	63 144	66 814	9 688	220 320	205 634
2008.	70 961	14 851	62 064	110 812	8 765	207 868	200 997
2009.	73 545	11 651	58 493	92 847	9 201	192 940	191 312

Source: made by authors, using www.dzs.hr

Table 2 shows that the number of passengers carried in railway traffic increased from year to year, and that in 2009 it was 84,6% increase as compared to 2005. In the same period, the amount of carried goods registered 18,71% decrease.

In the same period the number of passengers in road traffic decreased by 9,81%. While the amount of carried goods reached its maximum in 2008, and there was an increase of 88,18% as compared to 2005. In 2009 it was a decrease of 16,21% as compared to previous year.

The amount of transported oil and gas was constantly varied around 10% during the observed years.

During the years both types of urban transport recorded trends of increase and trends of decrease. The number of passengers carried by tram was the highest in 2007 (an increase of 18,08% as compared to previous year). A similar situation happened with the number of passengers carried by bus. In 2007 there was an increase of 8,21% as compared to previous year.

3.3. Air Traffic

Air traffic takes place through the air by plane heavier and lighter than air, and it requires a specially regulated beginning and ending point – the airport. The following table shows the number of carried passengers and the amount of carried goods of this type of traffic.

Table 3 shows that the number of passengers carried in the air traffic was the highest in 2008 and it registered a 10,96% increase, as compared to 2005. Next year it recorded a decrease of 11,85% as compared to previous year. The amount of carried goods was the highest in 2005, but during the period from 2005 to 2009 it registered a decrease of 37,12%.

Table 3. Air transport

	Air transport of passengers and freight	
	Passengers carried, '000	Freight carried, t
2005.	2 099	6 088
2006.	2 148	5 637
2007.	2 288	5 648
2008.	2 329	5 136
2009.	2 053	3 828

Source: made by authors, using www.dzs.hr

3.4. Traffic Of The Telecommunication

Traffic of the telecommunication is „any transaction, admission, or transmission of signs, sounds, signals, images or writing text any kind by wire, radio, luminous, or other electromagnetic systems.“[5] The following table shows the number of users and the quantity of sent messages.

Table 4. Traffic of the telecommunication

	Telecommunication services				
	Number of main telephone lines (fixed), '000	Mobile network users, '000	SMS messages, mln	MMS messages, '000	Total number of Internet users
2005.	1 677	3 650	2 429	10 409	1 472 400
2006.	1 654	4 395	2 553	14 909	1 684 600
2007.	1 687	5 035	2 724	21 643	1 984 850
2008.	1 724	5 880	3 812	43 641	2 244 420
2009.	1 707	6 035	3 490	23 954	2 495 453

Source: made by authors, using www.dzs.hr

Table 4 shows that the number of main fixed telephone lines during the period registered an increase, except 2009 when there was a decrease of 1%.

The mobile network users during the period from 2005 to 2009 registered an increase of 65,34%.

It is interesting to notice that the number of MMS messages in 2008 had the strongest increase, when it increased by 101,64% as compared to the previous year. But next year it registered a decrease of 45,11%.

The total number of Internet users registered a steady increase during the period and in 2009 there was an increase of 69,48% as compared to 2005.

3.5. Space Traffic

Space traffic takes place in space. There are special assets (spaceship, space stations, satellites, special manned or without them). Spacecraft, the launch pad and spaceport are very sophisticated and very expensive objects. So, this type of traffic develops only in a few countries around the world (USA, Russia, China).

3.6. The Representation Of Certian Transport Of The Entire Traffic Of The Republic Of Croatia

The data collected in this work shown each type of traffic. Their representation in the entire traffic of the Republic of Croatia will be shown below.

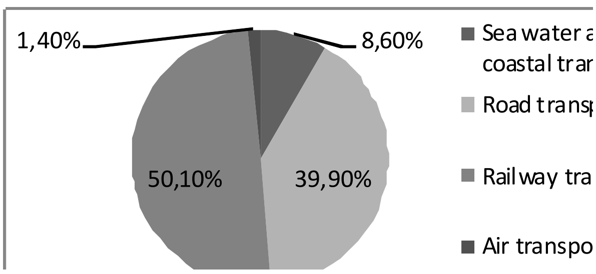

Fig. 1. Structure of transport of passengers, by types of transport, 2009, using www.dzs.hr

Figure 1 shows that the highest number of passengers realized in the railway transport, while the air transport realized at least.

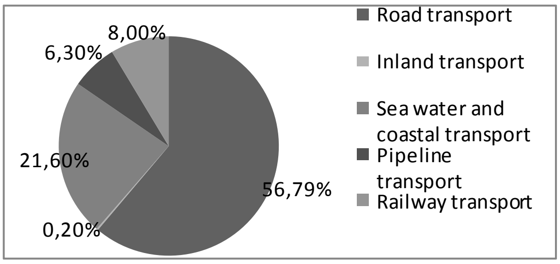

Fig. 2. Structure of transport of goods, by types of transport, 2009, using www.dzs.hr

Figure 2 shows that the greatest quantity of goods also realized in the railway transport then followed the maritime and coastal transport, and at least the inland transport.

4. CONCLUSION

The paper shows that the traffic is a really the blood circulation of any economic system. The state loses its meaning without it.

The analysis shows that all types of traffic system of Republic of Croatia during the observed period had trend of an increase and trend of decrease. It is also proved that the crises affected on it, and in 2009 it registered a decrease of its activity.

The second part of analysis shows that in 2009, in the structure of carried passengers the railway transport takes the largest share (over 50%), while in the structure of carried goods the road transport takes the largest place (over 56%).

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Modeling of mutual insurance system development in Republic of Bashkortostan

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Abstract

Mutual insurance seems to be quite an efficient tool of supporting insurance needs both for individuals and business. The main advantage of mutual insurance is lower level of insurance rates as compared to commercial sector. Zero-profitability of mutual insurance and lower level of commercial expenses are the sources of economy.

The law on mutual insurance was signed and published in Russia in year 2007 regulating the relationships, rights and responsibilities in the sphere of mutual insurance. Basic element of mutual insurance system is mutual insurance society which is a specific type of non- commercial organization. After three years the law was published, only 6 mutual insurance societies were registered on the territory of Russia, and none on the territory of Republic of Bashkortostan.

System dynamic model has been worked out to analyse causes preventing mutual insurance system active development and options of the process management. The model enables to calculate the system dynamics in various conditions and to estimate economical outcomes of the process.

Keywords: System dynamic modeling; Mutual insurance; Cognitive diagram; Flow-oriented models.

1. INTRODUCTION

Mutual insurance seems to be quite an efficient tool of supporting insurance needs both for individuals and business. Largescale use of mutual insurance internationally is proved by the following figures: approximately 90% of life insurance market in Japan, 60%, 50%, 50% in USA, Canada, Great Britain relatively. Mutual insurance share on propriety insurance market accounts approximately 50%, 40%, 30% in Sweden, Finland, USA relatively [1].

The law on mutual insurance was signed and published in Russia in year 2007 regulating the relationships, rights and responsibilities in mutual insurance sphere. After three years the law was published, only 6 mutual insurance societies were registered on the territory of Russia, and none on the territory of Republic of Bashkortostan. It is noteworthy, that particular features of current Russian insurance system, namely, high level of insurance rates and unconscientiousness of commercial insurance sector provide stimulus for mutual insurance system active development.

Causes of mutual insurance system poor development and factors influencing the process are discussed in [2, 3], but these researches are mainly descriptive. In order to get quantitative forecasts of mutual insurance system development in various conditions, system dynamic model has been worked out.

2. METHODS AND MATERIALS USED IN RESEARCH

System dynamics modeling tool named Vensim PLE developed by Ventana Systems [4] was used in the research. It’s advantages are listed below:

- Vensim PLE is free for educational and research purposes;
- Vensim PLE supports full cycle of system dynamics modeling.

3. RESULTS AND ACHIEVEMENTS

3.1. Cognitive diagram of mutual insurance system development

According to the system dynamics modeling methodology [5], cognitive diagram was designed in the first place. Cognitive diagram is a graphic model enabling to describe an object or a process as a system of variables interrelated by feedback and feedforward relationships. Cognitive diagram of mutual insurance system development is shown on figure 1. Key variables of mutual insurance system development are:

- the ratio of property risks insured by mutual insurance system to total property risks insurance market capacity. This variable measures popularity of mutual insurance;

- the ratio of property risks insured by mutual insurance system to property risks insured by commercial insurance system. This variable measures competitiveness of mutual insurance.

Key variables dynamics depends on following factors:

- the attractiveness of mutual insurance. That particular features of current Russian insurance system, namely, high level of insurance rates and unconscientiousness of commercial insurance sector provide stimulus for mutual insurance system active development;

- awareness of population and business in the sphere of mutual insurance. Since the law on mutual insurance had been signed and published in year 2007, nothing has been done for advertising mutual insurance. The survey realized in year 2009 [2] indicated, that population majority knows nothing or has wrong ideas about mutual insurance. It definitely slows down mutual insurance system development;

- complexity and high expenses of mutual insurance society establishment. In current moment it is necessary to get a license and go through complicated registration procedure.

3.2. Model as a set of interworking submodels

In order to make model understanding easier, it could be described as a set of interworking submodels: the submodel of decision making in insurance sphere; the submodel of insurance objects states; the submodel of mutual insurance societies number dynamics; the submodel of insured propriety risks dynamics; the submodel of financial flows in the insurance system.

The submodel of decision making in insurance sphere is a core of the model. It's levels are numbers of policyholders in different states, flows are transitions of policyholders from one state to another.

The following ideas are at the bottom of the submodel:

- decision making in insurance sphere are managed by the following mechanisms: advertisement, "jungle telegraph", personal experience in insurance sphere;

- advertisement efficiency depends on a number of add actions, audience size, personal experience in insurance sphere;

- "jungle telegraph" means, people could be induced to use insurance services through intercommunication with persons having positive experience in insurance sphere. The efficiency of "jungle telegraph" depends on voluntary advertising agents prevalence, intercommunication intensity and personal experience in insurance sphere;

- there are two ways of insuring propriety risk in mutual insurance system. The first one is through making contract with existing mutual insurance society. The second way is through establishment of new mutual insurance society.The choice between the two ways depends on mutual insurance ubiquity and complexity of mutual insurance society establishment.

Insurance objects states submodel describes insurance objects transitions between three states: OC_1- insurance objects, which potentially could be insured; OC_2- insurance objects, insured by commercial insurance system; OC_3- insurance objects, insured by mutual insurance system.Flow-oriented diagram of insurance objects states submodel is shown on Figure 2.

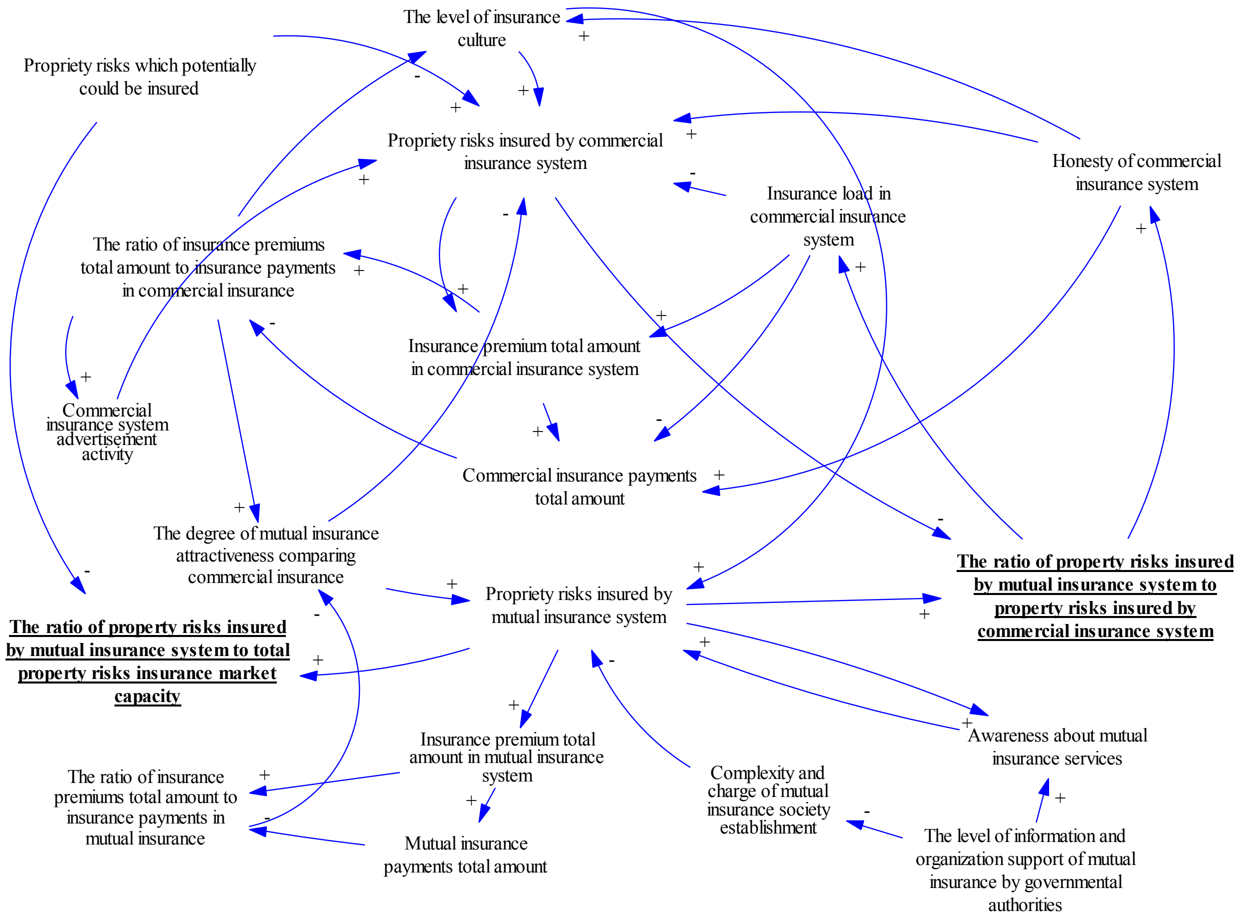

Fig. 1. Cognitive diagram of mutual insurance system development

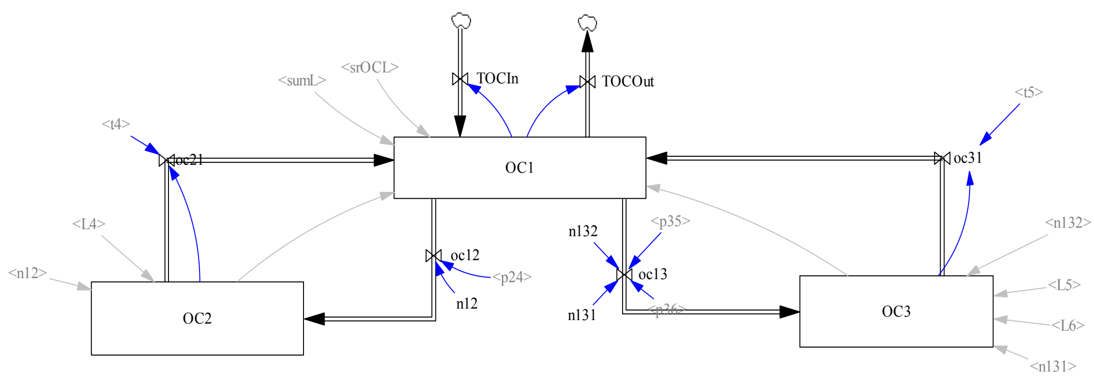

Fig. 2. Flow-oriented diagram of Insurance objects states submodel

Flow-oriented diagram of mutual insurance societies number dynamics submodel is shown on Figure 3. There is only one level variable in the model- NBC is a number of mutual insurance societies in the region.

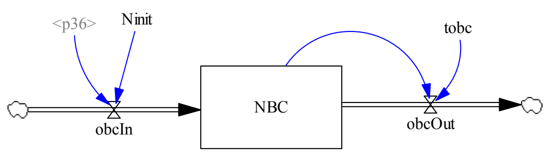

Fig. 3. Flow-oriented diagram of mutual insurance societies number dynamics

Flow- oriented diagram of insured propriety risks dynamics is shown on Figure 4.

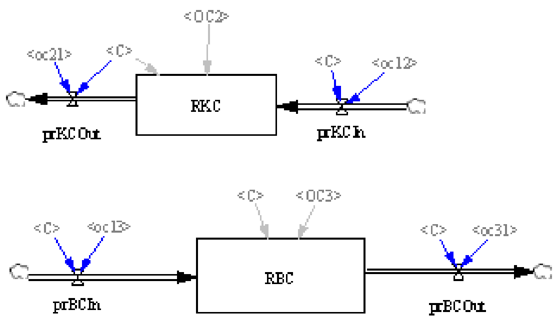

Fig. 4. Flow- oriented diagram of insured propriety risks dynamics

The following level variables are used in the model: RKC- propriety risks insured by commercial insurance system, RBC- propriety risks insured by mutual insurance system. This model is connected closely with the submodel of insurance objects states.

4. CONCLUSIONS

Mathematical model of mutual insurance system development is designed on the basis of system dynamics methodology. Both cognitive diagram and flow- oriented model are realized using Vensim PLE tool. The main advantages of the model are flexibility, complexity, capability for calculating system dynamics in various conditions and estimating economical outcomes of the process.

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Comparative analysis of CRM utilization in conditions of enterprises in Slovakia and Hungary

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Abstract

The customer relationship management is the term well known in services and telecommunication sphere, but less known in manufacturing and industrial enterprises. The article describes utilization customer relationship management in medium and large manufacturing; industrial enterprises in conditions of Slovakia and Hungary and compares differences and similarities between two bordering countries. The main methods used for writing the articles were statistical analyse, analysis method, method of induction and deduction, controlled interviews. The output of the summarized, structured data will be used for creation of methodology for customer relationship management establishment and application in the analyzed enterprises.

Keywords: Customer; Relationship; Enterprise.

1. INTRODUCTION

The Customer Relationship Management or CRM is 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 [1]:

- 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 t 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 [1].

The idea of CRM is that it helps businesses use technology and human resources to gain insight into the behaviour of customers and the value of those customers [1].

With an effective CRM strategy a business can increase revenues by [1]:

- providing services and products that are exactly what customers want,
- offering better customer service,
- cross selling products more effectively,
- helping sales staff close deals faster,
- retaining existing customers and discovering new ones.

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 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. This paper compares utilization CRM in industrial enterprises of two post-communist, Central European countries (Slovakia and Hungary).

2. METHODS AND MATERIALS USED FOR RESEARCH

The main objective of the research was to determine knowledge and use of CRM in medium and large, industrial enterprises in Slovakia and Hungary. To determine the stated objective it was necessary to use several methods and approaches, which were: *managed personal interviews* (with experts on the issues in enterprises), *questionnaire research* (in the Slovak Republic and Hungary) and *statistical methods* (one-dimensional descriptive statistics - frequency table, pie diagrams, one-inductive statistics -statistical significance test). Also were used other methods like methods of analysis, synthesis, deduction, induction and comparison. Research was attended by 76 enterprises (60 from Slovakia and 16 from Hungary). One questionnaire always represented the situation in one enterprise. Data from the questionnaires were distributed and collected electronically. All questions were answered by managers (sales manager, marketing manager and sales and training manager, quality manager) and also head of various sections in enterprise (head of commercial department, etc.) For the purpose of research were developed 5 hypotheses:

Hypothesis H1: Enterprises with foreign capital participation are familiar with the contents of a customer relationship management better than enterprises with the participation of the Slovak and Hungarian capital.

Hypothesis H2: Enterprises with foreign capital participation use customer relationship management more frequently than enterprises with participation of the Slovak and Hungarian capital.

Hypothesis H3: I Suppose, that 50% of businesses has established a comprehensive system for managing customer relationships.

Hypothesis H4: I Suppose, that 50% of businesses undertake educational activities and training-oriented customer care.

Hypothesis H5: I assume, that enterprises don´t take care on cultural differences of their customers.

3. RESEARCH RESULTS

Results obtained in both countries are very similar. This is mainly due to the similar situation in enterprises and also due to near position of both countries.

Responses from both countries will be compared and the differences or similarities will be described in this part of article. The main questions and also the answers of the empirical research findings and results can be interpreted as follows.

The most important findings are, if the enterprises know the customer relationship management and also if they use the principles of customer relationship management in their enterprises.

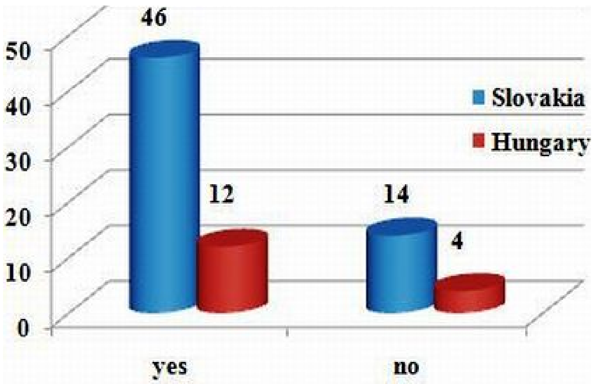

Fig. 1. Knowledge of CRM in enterprises

The figure 1. describes knowledge of CRM, 77% of enterprises in Slovakia and 75% of enterprises in Hungary have knowledge about CRM. It is clear that CRM is for enterprises operating in Slovakia and Hungary good known and it does not affect the type of ownership structure.

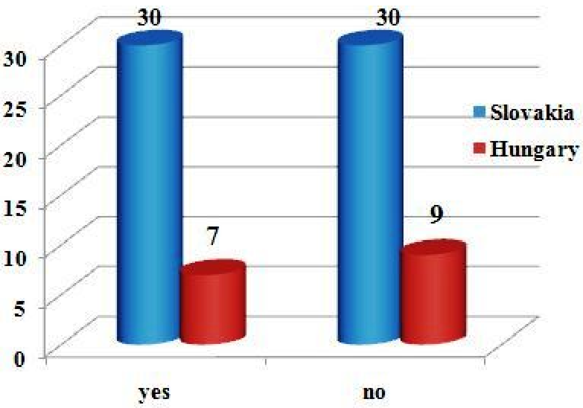

Fig. 2. Utilization of CRM in enterprises

The situation is different in the use of CRM in enterprises, only 50% of enterprises in Slovakia use principles of CRM, in Hungary the percentage is even lower, only 44%. CRM is used in this case more frequently by companies with foreign capital participation.

Another question was directed to determine, whether companies have a comprehensive CRM system. Only 25% of enterprises in Hungary and 33% of enterprises in Slovakia have established integrated CRM system. The positive is fact that enterprises are planning to establish the system within two years. The positive is that enterprises have built software to support customer relationship management. Most enterprises use ERP systems/software (40% share in Slovakia, 50% in Hungary), only 20-25% is used CRM system.

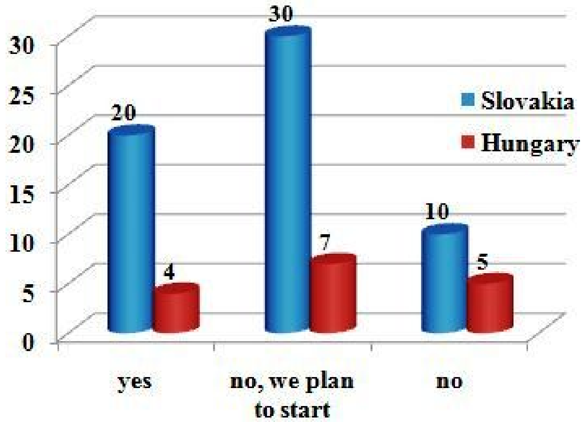

Fig. 3. Utilizing of CRM system in enterprises

The right approach, adequate and professional behavior of employees to the customer is very important for building and maintaining relationships with customers. Educational activities focused on the customer carries out more than 50% of enterprises.

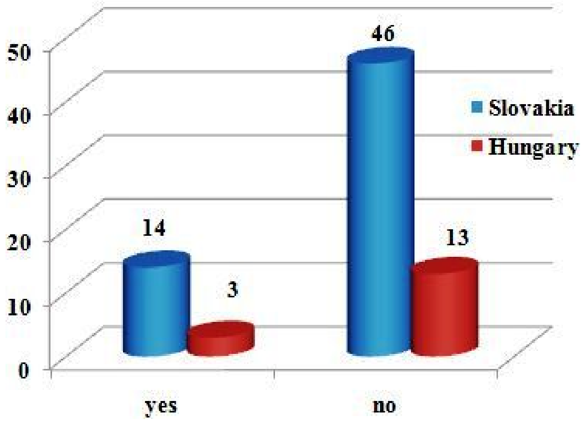

Fig. 4. Cultural differences of customers and educational activities in enterprises

Enterprises are trading also with foreign customers, so it is necessary to know the cultural differences of customers and cultures. Figure 4 represents how enterprises educate their employees in area of customer cultural differences. In Slovakia and also in Hungary enterprises don´t pay enough attention to the cultural differences of their customers. Only 23% of enterprises in Slovakia and 19% of enterprises in Hungary realize educational activities in this field.

In consideration on given facts it is possible to prove or disprove the mentioned hypothesis. The knowledge of customer relationship management doesn´t depend on the ownership structure of the enterprise, hypothesis H1 is therefore not accepted, exactly opposite situation is in the case of hypothesis H2, so H2 is proved. Comprehensive system for managing customers uses only about 30% of responded enterprises, so the hypothesis H3 is disproved. Up to 54% of enterprises conducted educational activities focused on customer care, while implementation of these activities depends on the ownership structure and number of customers. The hypothesis H4 is accepted. Despite the fact that 90% of enterprises is trading with foreign customers, only 22% of enterprises educate their employees in area of customer cultural differences. The hypothesis H5 is accepted.

According to the present research and also according to research compiled by Mr. Lendel, we can conclude [2, 3]:

- Top management does not pay enough time and space for customer related problems,
- 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.

4. CONCLUSIONS

Currently, the enterprises are increasingly aware that it is not enough just to provide products and services of superior quality for a reasonable price, more and more the customer gets to the fore. With a view to meet the needs of their customers faster, better and achieve competitive advantage, enterprises use customer relationship management. Often, the philosophy of customer relationship management is wrongly understood only as software or project after reaching a certain destination is closed [4].

It is very important for enterprises operating in Slovakia and Hungary to understand that CRM is not only fashionable thing, but the whole philosophy of the company from top management to their employees.

5. ACKNOWLEDGEMENTS

This paper is a part of a doctoral thesis.

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Knowledge Management at Job Interviews

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Abstract

Knowledge management starts from the job interviews and has its importance for later knowledge managing. This resarch has a goal to indicate the importance of Knowledge management at the first meeting with a candidate for a job – at the job interview. Both, potential employee and employer have to do their own part in knowledge management. Each employee has a chance to present best of himself through short job interview, to sell himself, to show his knowledge, skills, qualities and to present what use potential company would have if hiring him. As from employers aspect many questions have to be answered so careful and precise thinking and question forming leads to finding a right person for the job. An Interview with both employers and potential employees is used as the main method for the research. The approach to the research is that planning, job analysis, precise defining of needed knowledge, skills and interests of appropriate candidates is of huge importance which leads to eliminating potential problems in wasting time, unneeded educating costs, difficulties with the employee towards buyers, fluctuation of the employees. If not using appropriate knowledge management from the start, from the Job Interviews both organisation and employees could experience multiple problems.

Keywords: Knowledge management; Job interview; Employer; Employee; Costs.

1. INTRODUCTION

We are living in the time of financial crisis all over the world and many employees are ending up loosing their jobs. Many difficulties suddenly have to be dealt with and struggling with everyday financial problems can be very exhausting.

Looking for another job demands serious approach but that is the only way to get appropriate job. Preparing for the job interviews means thinking of every possible question that can be asked so knowledge management starts from the job interviews and has its importance for later knowledge managing. This resarch has a goal to indicate the importance of Knowledge management at the first meeting with a candidate for a job – at the job interview.

The same as in the sales in general, in very short time a potential employee has to reveal to the world his or her qualities, at what he/she is good at and to send a strong message to his employer.

As already mentioned, preparing for the job interview is of crucial meaning for the candidate the same as having certain knowledge and experience, but that is something you can't influence any more and probbably you wouldn't have come to the interview if you haven't have fitted.

On the other hand, the employer has a goal of finding the right person for the vacant job position so proper planning ensures more time to locate the best candidates as well as to send the right message about the job position to potential candidates.

Locating the best candidate can be done from many sources such as newspapers, internet, recommendations, employment agencies, learning institutions that teach what employers need or from inner sources recommendations such as employees that already work for the employer because they are best informed about the needed skills and knowledge.

Finding the right people to hire is much easier when employer first analyze the job they want to fill. Asking themself what kinds of people do the best in this job will give the answer to their question.

2. JOB INTERVIEW

2.1. Useful tips before job interview

While at home, preparing for the job interview it is useful for employees to follow few basic tips that can be helpful.

Try to find out the more you can about the company – about the products or services, about the market, competition, trends, current activities, priorities and salaries. Have ready the answers to possible questions, have your questions ready to ask employer what you want to know about the company, find out if there are any certain conditions before getting the job.

It is good to have your documentation about your qualifications, successes, and references prepared for the employer in case he needs it. Have 3 updated CV's ready for the interview (taken with you) no matter if you have already sent it - 1 example for you, one for the person that is interviewing you and 1 in case there are more people at the interview.

Think in advance about your personal goals and wishes, as well as what you have to answer if they ask you about it. Employers like positive attitude so it is very important to be positive and optimistic. Try to do the personality test before you go on the interview to discover your advantages and disadvantages so that you can prepare yourself to questions about it. Get dressed professionally.

2.2. Frequently asked questions

If candidate for a job studies well the list of frequently asked questions he has half of the job done. While answering questions be aware of how you express yourself, talk clearly and loudly, answer precisely but avoid using yes-no answers, don't lie, take your time for a second or two to prepare the answer in your head, be ready for unexpected questions and for hypothetic situation and don't allow anyone to get you out of line, be positive and constructive.

Telling something about yourself sounds simple but acctually it is not easy to give an answer to this question. Employer doesn't wanna hear your childhood story nor what you do on weekends. In few sentences point out your most important characteristics, your business achievements and your goals.

Where do you see yourself in five years is a question where employer wants to check how flexible you are and to what extent you are willing to adapt your plans to the needs and wishes of the company. A good way to give an answer to this question is: Primarly, I want to prove myself on the job and with my commitment to the company to progress in the company.

Giving the good reason to the employer to hire you, you have a good chance to get a job so this question is a part where you can sum up your experience and tell them how much of experience you have and how (in what way) you can contribute to the company.

Tricky question is the one considering your reason to change the job so it is suggested to give the answer to this question in a positive spiriti such as explaining that you were satisfied with your recent job but that you have come to the point where you haven't had a chance to progress anymore and that is why you have decided to move on.

Specifying your weaknesses can be tricky but you can make it to do the best for you by minimizing your weaknesses and pointing out your positive features. Be aware not to mention your personal features but your professional and don't leave the impression of being too perfect.

Employers want to know why would someone want to work for them, would it be because someone has applied for no special reason or because it was well-considered decision. It is suggested for the employee to point out the benefits of the company that attracted him/her to apply for the job.

If you have enough of working experience talking about the expected salary wouldn't be a problem for you and you can define the minimum salary that you would have accepted but if this is your first job or if you are just insecure about the answer you can answer this by asking what would be the salary for this position in the company.

By asking candidate what makes him happy at work employer wants to know what motivates employee so he can get the full picture about his /her preferences. It is good that employee describes the situation where he/her was happy about the job done or achieved success.

Defining your goals within the company is good to focus on short-term goals.

Employers like to hear if the candidate has prepared questions for them so it is good to have questions prepared but it is usefull to avoid routine questions that candidates usually ask just to ask something without any special interest in the answer. Such questions that are good to be avoided are: How many vacation days will I get?, When can I expect the raise?, When can I expect the promotion?, etc. [1]

3. THE IMPORTANCE OF CHOOSING THE RIGHT CANDIDATE

Interviewed employers and employees in this research have pointed out the importance of well prepared recruitment and job interviews.

It is in nobody's interest to fail with a choice of the right candidate especially when we observe it from the cost aspect – opportunity cost, psychic cost and non-manufacturing costs.

Opportunity cost, also referred to as economic cost is the value of the best alternative that was not chosen in order to pursue the current endeavor – it represents opportunities forgone. [2]

A psychic cost is a subset of social costs that specifically represent the costs of added stress and losses to quality of life. [2]

Non-manufacturing costs are those costs that are not directly incurred to manufacture a product, such as salary expenses. [2]

For the success of the company it is neccessary to have employee who is capable of converting his knowledge to company's knowledge.

Knowledge management can transform the organization to new levels of effectiveness and efficiency. The modern business manager is able to discover and learn new measures, new technologies and new opportunities, but this requires the ability to gather information in usable fortmats and disseminate knowledge to achieve the organization's objectives. [3]

Potential problems related to inadequate recruitment are:

- inadequate coverage of clients and lack of building existing relationships which can be of huge harm if we talk about the sales
- increased costs of training to overcome disadvantages of the employee
- difficulties in monitoring the employee
- higher fluctuation rates – when both employer and employee are not satisfied with the job done it is expected that they will look for another option but finding other options burdens the budget
- difficulties in establishing long-term relationships not just with clients but also with colleagues can damage working atmosphere and motivation within the employees which can result in lack of sales achievements

According to the Harvard Business Review, 80 percent of turnover is caused by bad hiring decisions. These are costly mistakes. The U.S. Department of Labor calculates that it costs one-third of a new hire’s annual salary to replace him. These figures include money spent on recruitment, selection and training plus costs due to decreased productivity as other employees fill in to take up the slack. But these numbers don’t reflect the intangible damages an exiting employee can have such as lost customers and low employee morale across the rest of the organization. And, turnover costs climb even higher as you move up the organization: mid- and upper–level managers can cost over twice their annual salary to replace.

The right person will make contributions to the company’s productivity and profitability that far exceed salary cost. But the wrong person can cost plenty. [4]

The right person is of great value to the company so many companies have certain employee benefits.

Employee benefits are in general, indirect and non-cash compensation paid to an employee. Some benefits are mandated by law (such as social security, unemployment compensation, and workers compensation), others vary from firm to firm or industry to industry (such as health insurance, life insurance, medical plan, paid vacation, pension, gratuity). [5]

4. CONCLUSION

While doing the research the Interveiw was the researching method. Both Employers and potential Employees were aware of the importance of the Job Interview.

As from Employers aspect it is of crucial value to precisely define the job and to use the right source for finding the appropriate candidates for a job. Focusing on skill levels that are engaged for the benefit of the company means having an organization with synergic effect of knowledge and skills.

As from Employees aspect the more they inform themselves about the hiring company the better chances they have to get the job. Also, having the confident and positive attitude leaves the good impression on the employer who will certainly consider these candidates for hiring but it is very important to want that job rather than applying for the job just not to be unemployed any more.

Managing our knowledge means making our knowledge work for us, in this case on both sides – for company/employers by preparing a good way to evaluate the candidates and for candidates to present/sell themselves in the best way. Synergic moment of employers and employees expectations means having a long-term relationship that is beneficial for everyone.

Difficulties, expenses or unneeded costs such as educating employees or wasting time if hiring the wrong candidate can rise to that extent that can be harmful on the whole team in the company. If employee is not satisfied with his job achievements he will also experience multiple problems such as lack of motivation, lack of confidence, lack of interest, etc. Knowing how to motivate employees in order to get the best selling achievements is much easier when employer has a good team that understands the goals of the company. The good team has to be made of highly motivated employees which can progress fast and that is why it is crucial not to waste any time by hiring the wrong candidate.

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Integrated Logistics in Automotive Industry

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Abstract

This article deals with the importance of integrated logistics in the automotive industry, which is ranked among the leading industries in Slovakia. It describes the logistics integration areas of automotive plant with supply and customer field. It pays attention to the service utilization of logistics integrators. It analyzes the importance of vertical logistics integration performing inside the plant too. First of all, the positive impacts on producer competitiveness are characterized. In the end the main proposals of next integrated logistics development in automotive industry destined to increasing its level are mentioned.

Keywords: Integrated logistics; Automotive industry; Logistics outsourcing; Company competitiveness.

1. INTRODUCTION

Integrated logistics is the last evolutionary stage of business logistics integrating all partial logistics chains in supply, production and distribution into one compact chain. Logistics becomes a co-creator of company strategy. [1]

The customer is situated at the beginning and at the end of this chain. He seeks more and more car variations and can change the desired configuration of his car at last moment. He is not willing to wait for a new car for several months. He accepts a few days waiting period. In case of the insufficient flexibility of the supply chain he refers to competitors.

We are convinced that integrated logistics is the best solution for this problem solving. The automotive industry is the largest provider of customized products directly to customers. Therefore, we analyzed the level of integration logistics in this sector.

2. METHODS AND MATERIALS USED FOR RESEARCH

Our research was mostly based on the method of directed interview with top management, middle management, lower management and workers in Slovak automotive industry. Because every automobile producer in Slovakia has a few hundred independent suppliers, he realizes integrating activities by means of the so-called logistics integrator. For that reason, we also focused on his services. He is able to consolidate supplies from many suppliers and assure regular supplies for assembly lines. The finished vehicle distribution and the management of transport units flows belong to his basic activities besides.

We focused on standardized information resources accepted by all parties in order to connect single segments of supply chains. So-called electronic logistics protocol is created in a few days advance for loading at the supplier. Thank to it, the producer knows beforehand that he can count on given supply. His supplier knows what he has to supply and he does not have to keep useless stocks. Logistics integrator has ample time to choose a suitable means of transport. Furthermore, the protocol contains a tool enabling to check the optimal utilization of transport capacities. Means of transport in automotive logistics are accommodated to side-loading, so electronic logistics protocols are able to illustrate their cross-sections and the exact location of single components. Information about the loading times at supplier, transport times, transport lines, used standardized boxes, etc. are available for all contracting parties. Protocols take the obligatory drivers' breaks, holidays and driving bans for trucks in transported countries affecting, first of all, working Saturdays into account.

The production order is one of the next key information resources. It defines the exact parameters of produced car and is the main information base mainly for synchronized supplies. It dictates the number of produced cars, so it significantly affects transport. If Kia Motors has to increase the ratio of Sportage to Cee'd, various changes result from it. Larger components will be required and more trucks will be needed. It will necessary to revise the electronics logistics protocols, negotiate new conditions with logistics integrators and modify the standards.

3. RESULTS AND ACHIEVEMENTS

On the ground of analysis of information received from automobile producers we have identified following problems that have to be handled for the next development of logistics integration in the Slovak automotive industry:

1) Services of logistics integrators are not interesting for some of the suppliers – A certain group of suppliers, which provides supplies in its overhead, exists within the supply of automobile plants. Automobile producers are subsequently forced to categorize their suppliers. The supply chain visibility decreases because of it and logistics processes are not uniform. Suppliers' interest can be elicited only by the expansion of logistics integrators' services. They should concentrate on sub-suppliers too in order to achieve the broader effects of logistics integration.
2) Logistics concepts of automobile producers are narrowly aimed – So-called "Das Neue Logistik Konzept" from VW [2] and "La logistique alternative" from PSA Peugeot Citroën [3] are mainly aimed at first-tier suppliers. In consequence of Modular Sourcing strategy automobile producers are supplied by complete modules. They lost contact with the original suppliers of components because of it. These are getting to the position of second-tier suppliers. It is necessary to ensure access to B2B portals intended for information sharing between automobile producers and their suppliers.

   Some big car companies, e. g. Honda, are looking for ways to get their suppliers more involved in the design of new vehicles. They are driving the design function down not just to their tier one suppliers but even further down to the suppliers of those suppliers. The idea is to design a car composed of many generic modules. This can really shorten the time to market for a new product. Honda is getting very good at this so they get new cars to market faster than other car makers. They do this by breaking a new car into sub-sections that can be designed and built simultaneously by different suppliers and then delivered to Honda for final assembly. [4]
3) Insufficient diversification of suppliers – Every automobile producer in Slovakia plans to increase the volume of production. VW has introduced a new project called "New Small Family". PSA Peugeot Citroën is going to switch over to the three shift operation because of the production of the new model of Peugeot 208. Kia Motors is going to produce more than 300 thousands of cars in 2012. Thank to it, its production plant will be fully utilized. We assume producers will have to proceed to the diversification of suppliers due to the deficient capacities of present suppliers. New space for logistics integrators will be created because of it. Producers will decrease present risks connected with dependence on only one supplier. There is less chance of disrupted supplies, as problems can be avoided by switching suppliers. Producers can deal more easily with varying demands and. Furthermore, competition between suppliers reduces prices and involving more organisations can give access to wider knowledge and information. [5]
4) Insufficient information integration with suppliers – In light of integrated logistics a homogeneous information solution is absent in automotive supply chains. It is common that producers and their suppliers use different information systems. They are forced to utilize a special translator (GSX server) in consequence of it.

Backward information integration is more feasible in the automotive industry due to the use of the internet, which enables not only first-tier suppliers (as in the past with the use of EDI) but also second- and third-tier suppliers to have access on production schedules and plans. Potential benefits as a result of increased information integration include improvements of the delivery reliability for customers, reduction in delivery times for customer-specific vehicles and, of course, cost reductions. The number of people needed to contact suppliers has been mostly cut. [6], [7]

5) Low flexibility of logistics outsourcing contracts – Many processes are ensured by logistics outsourcing within the frame of integrated logistics. Contracts with external service providers are often passed for a long time period. It may have a negative impact on the flexibility of outsourcing partner. He adheres strictly to the contract, so he is not able to flexibly react to moving producer's requirements and his proposals relating to the optimization of processes. Employees of producer subsequently perform some activities instead of employees of outsourcing partner.

6) Insufficient flexibility of order satisfaction – If a customer orders an exactly appointed car from the car dealer, waiting period may be even two weeks. Production time, i. e. way between input to the welding shop and output from the assembly, is for example in PSA Peugeot Citroën only twenty-three hours in comparison with mentioned time. Producers should concentrate on time reduction of supply and distribution processes. Free taking of car direct from production plant could be one of the first steps.

   Producers can postpone the final assembly of vehicle. Some elements of vehicle customization could take place between factory and dealer at the distribution centre, where stocks of easily interchangeable modules and body parts are held so that other features can be changed or added as required, without introducing unnecessary complexity on the production line. [8]

7) High range of securitization – According to available information from automobile producers, order is dispatched to suppliers (with exception synchro suppliers) in six days before material input to plant. Thank to it, the material is available for production for a period of six days. Furthermore, one more securitization is available. It achieves from four to fifteen hours in dependence on the distance of the supplier. If a producer wants to reduce the lead time, he has to reduce these times.

8) Insufficient reactive capability of information systems – Production plans are generated in eight days before material input to plant. This shows that systems generating orders have two days to generate sufficient volume of orders for assurance of production requirements. It is necessary to reduce this time in order to increase the supply chain flexibility.

9) Enforcement of System Sourcing strategy – Automobile producers permanently decrease the depth of production and increasingly concentrate on assembly. It comes to the transition of generated value from producers to suppliers. Producers have to transfer more competencies on suppliers. Consignment stocks belong to the first steps of automobile producers in this area. These stocks are managed by the supplier and are intended for storage of coil sheet needed for the pressing shop and for storage of chemicals needed for paint shop. Suppliers become the carrier of know-how, innovation potential, quality and rising utility value. For that reason, producers have to involve suppliers in the processes of research and development, preparation of production and assurance of rising customer requirements.

4. CONCLUSIONS

We are conscious that the proposals for these problems solving have to go from the decisions of foreign centers of automobile concerns. It will be a long-term process. Its timing is very important. On our opinion, the modification of the product portfolio and the introduction of technology innovations in the Slovak automotive industry is an opportune moment. The contribution resulting from development of the integrated logistics concept will be observable in mechanical engineering, electrical engineering, plastic production, rubber industry, etc. on the score of interconnection with other industries. Thank to it, Slovakia could achieve a positive effect on the gross domestic product formation, the trade balance deficit decreasing and employment rate increasing.

5. ACKNOWLEDGEMENTS

We would to thank to PSA Peugeot Citroën in Trnava for help in the research.

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The Application of Statistical Methods and Tools for Managerial Decision Making

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Abstract

The significant part of organizational management is one of the most important activities, managerial decision making. For each activity that we do, whether it's routine or one-off, we have to decide always. Managers are invested with the task of making decisions which routinely affect the value and viability of organizations. Decision is very important and the key to change.

Problems frequently faced by mangers typically involve the decision whether or not to do something given the condition of an expected result of their given choices. Decisiveness, as skills in decision-making, distinguishes very good managers from very bad managers. A person who is not good in decision making is not fit to be called a manager but an administrator.

Good managers do effective decisions. Effective decisions are based on the analysis of data, information and this leads to the fulfilment of the organizational goals. Therefore, it's necessary to make decisions based on the facts.

Managers at the various levels of management should be to decide based on the results obtained using different statistical methods and tools. Statistical methods and tools provide to study of the phenomena and to make objective conclusions about them. And it's in the solving the most various problems and in many areas of human activity. They're very effective tools for management and decision making at all levels of management.

This fact was the basis for carrying out research use of statistical methods and tools in practice. In the paper is emphasis on the application of statistical methods for managerial decision making. The paper will be presented the partial results and conclusions of investigations carried out.

Keywords: Managerial decision making; Decisions based on facts; Statistical methods and tools.

1. INTRODUCTION

One of the basic management functions is management deciding, what is done in order to achieve certain goal.

The decision making is a process of analyzing and considering, of searching various solution options and, following certain criteria, selection of a way that results in decision. Each decision is a result of dynamic process that is influenced by many factors, amongst which belongs environment of the organization, managers´ abilities, motivation and naturally not lastly facts and evidence, which influence decision making significantly. [1], [2]

Management deciding is, to some extent, an intersection of intuitive deciding and deciding based on facts. Intuitive deciding is influenced by experience, knowledge, by skills of manager who is deciding. Fact based deciding is done upon gained and analyzed data, which provide facts and evidence about actual reality "problem" situation.

2. STATISTICAL METHODS AND TOOLS

Within management deciding we can often find lot of data in various forms, e.g. data gained from measuring production process, files of data from various researches or experiments, or data from market researches etc. [2], [3]. At such situation – with lot of data – in any area, statistics is helping us.

The statistics is a tool for supporting decision making. It is not doing the decision, but supporting it. Quality of deciding is different when we are not deciding only intuitively and we take in account also various numeric data, i.e. facts, evidence about reality. Data gathering, data processing, inspection, analysis and elaboration of recommendations for decision making, describing phenomenon by data and transform data to information are tasks of statistics – component of decision making process.

Statistics as a scientific discipline has numerous statistical methods (as e.g. are Hypothesis Testing, Regression and Coleration Analysis, Reliability Intervals, Factorial Analysis, Statistical Process Control, ANOVA, Discrimination Analysis etc.) and tools (as e.g. are Cause-and-Effect Diagram, Pareto Analysis, Histogram etc.), which have their own use in various areas of management, e.g. in marketing, logistics, production, quality management system (QMS).

Using statistical methods in business practice has its own substantiation what also proves the fact that even the International Organization for Standardization (ISO) is dealing with the specified topic.

The ISO been issued 74 International Standards, where is set out the practical methodology for collecting, processing and interpreting measurement, testing or inspection results whenever goods or services are assessed from a sample. ISO International Standards for the application of statistical methods are generic and widely used in many technical fields. Not only are they used by organizations in all business sectors worldwide, but they are also cited in hundreds of ISO International Standards on specific products, processes and materials. [4]

Despite this, applicability in various areas does not respond to possibilities which are provided by statistical methods and tools.

3. METHODS AND MATERIALS USED FOR RESEARCH

Following the aforesaid facts, the research was carried out in 2009 and 2010. Its subject matter presented the mapping of the system security current state concerning the complaints management in terms of business practice in Slovakia. Part of the research was the mapping use of statistical methods and tools in practice, too.

The research hypotheses were set up, which were verified with using a wide range of scientific methods of acquiring and processing data - observation, questionnaire, interview, qualitative methods (for example analysis, synthesis, induction, deduction, comparison, abstraction, etc.); quantitative methods (for example descriptive statistics such as frequency analysis, statistical analysis, such as hypothesis testing, confidence intervals), graphical methods for example bar charts, pie charts, tables, diagrams, flow charts etc.), the principle stratification and a number of other creative methods and techniques.

Approximately 400 business subjects on the Slovak market were addressed within the research. Concerning the subject of business, the sample consisted of 45% business subjects of production character and 55% of those providing services. One of the important steps was to find out if the business subjects joining the research built the quality management system (QMS) according to the international standard ISO 9001 (Figure 1).

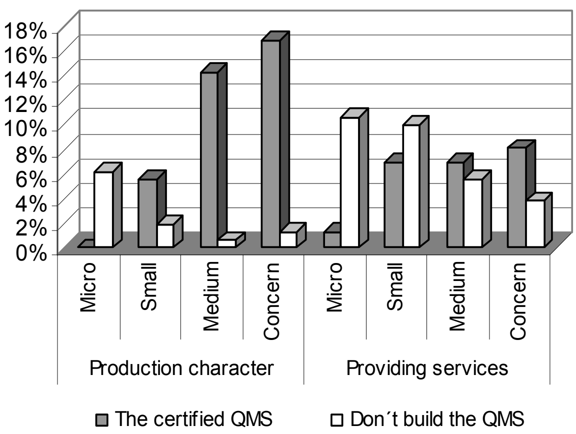

Fig. 1. Visualisation of the business subjects from the quality management system point of view [5]

Research results were obtained with the help of different scientific methods, SPSS software and using the comparative analysis they were compared with the results arising from previous researches that had formed a part of the research projects realized at the Institute of Industrial Engineering, Management and Quality; Faculty of Materials Science and Technology in Trnava; Slovak University of Technology in Bratislava, Slovakia (FMST SUT; the scientific grant project VEGA No. 1/0103/03 “Monitoring costumer satisfaction in quality management and marketing” - 2003 – 2005 and No. 1/7162/00 “The quality of the communication system as a factor affecting competitiveness of SMEs” - 2000- 2002), as well as researches conducted at other universities in Slovakia.

4. RESEARCH RESULTS

Results of analysis of current use of statistic methods and tools within business practice in Slovak market are presented in the table No. 1, where the significance of differences in the distribution of business subjects’ answers in individual features of examined categories is formulized.

Considering the main goal of the research, we observed the use of statistic methods and tools during monitoring of customer satisfaction and in quality management. Both areas mean for business practice a feedback and thus gained data are important in management deciding.

Based on the results in table 1 one of the hypotheses was checked, H_0 : *There are no significant differences in the use of statistical methods and tools in the business practice*. If we look at the results in table 1, we find out the there are significant differences in the use of statistical methods and tools in the business practice. Significant differences are caused by systematically influences such as:

- The positive effect also has implementation of the existing ISO 9000 series of standards into business practice. The standard ISO 9001 in the chapter 8. Measurement, analysis and improvement is said, that processes have to include identification of statistical methods and tools and the extent of their use.
- Business subjects with production profile are using statistical methods and tools in a bigger extent what is apparently caused by the character of their business subject.
- The use of statistical methods and tools is preferred rather by mid and large sized business subjects and concerns, what is apparently caused by the amount of human capital and financial potential.

Based on results contained in the table No. 1 we reject the Hypothesis H_0 at 95 % probability.

5. CONCLUSIONS

As it may be seen from part of the research conclusion (expressed on confidence interval 95 %), the business subjects on the Slovak market are still supposed to improve. First of all, they have to realize that if they want to make right management decisions, it is necessary to go out from relevant information, data, factors, which they gain by right selection and use of statistical methods and tools.

The basis of statistical methods and tools is using de Marco’s principle *“We can’t control what we can’t measure”*.

The paper presents the partial outputs from the Ph.D. thesis in field of study "Production Quality Engineering". The Ph.D. thesis was awarded the "Prize for the Best Student’s Work in the Field of Quality Management 2010" Slovak Society for Quality and as well as FMST SUT, too.

Table 1. Formulation of the significance concerning the differences between various categories of the features in the field use of statistical methods and tools during monitoring of customer satisfaction and complaints management [5].

Requirement	Subject of business	Size by number of employees	QMS
Implementation process monitoring customer satisfaction	0,06326582	* 0,00000000	*** 0,00000000
Statistical methods and tools used during customer satisfaction	0,07643077	*** 0,00000000	*** 0,00000106
Analysis and evaluation of monitoring information	* 0,01346110	*** 0,00000000	*** 0,00000000
Use of computer support for processing data which were gained from monitoring.	0,23840260	*** 0,00003879	*** 0,00000549
Use of statistical methods and tools for assessing information from questionnaires expressing satisfaction.	* 0,01244304	*** 0,00000000	*** 0,00000003
Transmission of feedback information from customers in the production stages	** 0,00109516	0,19511887	*** 0,00604903
There is the use of statistical methods and tools for quality and process improvement implemented at the whole organization.	** 0,00172863	*** 0,00000000	*** 0,00000000
Employees are briefed about the use of statistical methods and tools.	* 0,04548974	** 0,00343041	*** 0,00072802
Developed procedures/techniques describing the use of statistical methods and tools	*** 0,00003491	*** 0,00000000	*** 0,00000000
Use of statistical methods for analysis and dissection of complaints/claims.	*** 0,00006767	* 0,01430053	*** 0,00000005

Comments: *** Very high significance, ** High significance, * Significance, - Don't significance.

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Competencies of a Project Manager

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Abstract

Every enterprise irrespective of its size, type of business it is involved in, or its culture has been from early times involved in project management. However, in last 10 to 15 years, project management has been taken as a separate task and occupation by businesspersons. An enterprise appoints a project manager who is liable to tasks and functions that lie in his vicinity of job specifications. The demands made on project managers are called managerial competences. A competency is a combination of inherent traits, skills, attitude and behaviour. The project manager is the central element in accomplishing project success. Successful project involves project managers possessing skills related to the objectives of project completion. To find a good project manager (or people working on the projects) is one of the most important and demanding task. Long-term statistics show that more than 60 % of the problems in the projects have its origin precisely in the social area. Simply put, their cause is not the methodology, lack of money or time, but, their needs, motivation and relationships. And there really does not help either methodology expert knowledge of the topic, but how a project manager can to work with people. In many areas inflected combination of soft skills is also important in projects. The project manager is in fact mainly a manager who is responsible for project planning and management. Many of the current manager's soft skills of are applied in projects, but some are just for specific reasons, which the projects differ from general activities.
The paper offers a review of the skills and competencies required by project managers to effectively discharge their responsibilities.

Keywords: Project manager; Competence; Competency; Project management; Enterprise.

1. INTRODUCTION

Nowadays many enterprises, whether large or small, recognise project management as a core business capability. They seek to reap the benefits to the business through effective managing projects. As a result of the problems of defining and measuring competency for project managers are exercising the profession's leading researchers and practitioners alike from the field. Project management is increasingly recognised in a world and requiring mastery of a vast range of behaviours honed to suit the particular project and organizational context. Project management competency describes those behaviours that enable effective managing projects [1, 3, 4, 5, 6].

This paper presents the outcomes of a research that examined the current state of competencies development of project managers in selected enterprises in Slovak republic - mainly in manufacturing enterprises. The paper focuses on the general aspects of skill and knowledge development, since that presents commonality for the different project types.

2. PROJECT MANAGEMENT COMPETENCY AND COMPETENCE

The very term competency comes from the Latin word "competens" (suitable, appropriate, proper etc.). "Competentie" can be translated as "somebody, who has the right to judge" or "somebody, who has the right to speak". In general use, terms such as knowledge, skill, attitude, ability, capability, aptitude and performance are often used interchangeably with the term competency. It is important to clarify the generally accepted usage of the terms (see below Table 1).

Table 1. The differences between competency and competence [3].

INPUT	OUTPUT	OUTCOME
COMPETENCIES	**COMPETENCES**	**SUCCESSFUL PROJECT DELIVERY**
In general, cover a wide range of different situations.	Based on a work task and relate to a particular role or job.	Performance
Decision Making Ability, Personality, etc.	Execution of Risk Management. Maintaining Stakeholder Commitment etc.	Delivered project objectives. On course to achieve benefits. Stakeholders satisfied.

Although long discussions are held about it – the term "competence" better captures the essence in the Slovak language. It is also necessary to distinguish a project management competence and a competent project manager. Project management competence is the demonstrated ability to perform activities within a project environment that leads to expected outcomes based on defined and accepted standards. [1, 3, 4, 5, 6].

3. PROJECT MANAGEMENT COMPETENCE FRAMEWORKS

Competences can be measured in similar ways using self assessment and (or) peer assessment against a competence framework, or assessment centres (for example APM® Practitioner Qualification etc.). Listed below are two examples of project management competence frameworks [3, 6].

PMI® - PMCDF®[1] (Project Manager Competency Development Framework® - 2nd edition in 2007) is a standard developed by the PMI®. The standard provides guidance the general principles for defining project manager competence. [3, 5, 6].

IPMA® - ICB®[2] (IPMA Competence Baseline® - 3rd edition in 2006) defines the knowledge and experience expected from the project managers. It was issued by the IPMA®. The foundation of this standard is that competence is best indicated by a demonstrated ability to apply knowledge and skills. [5, 6].

4. METHODS AND MATERIALS USED FOR RESEARCH

The research was conducted among project management related employees worked in the manufacturing enterprise of Slovakia via portal questionnaire. The questionnaire was divided into two parts. Part 1 sought details of general background. Part 2 sought views on the importance of a competences identified from the literature and their current ability to use it. The respondents were answered on closed, open and semi-open questions. The respondents were requested to evaluate the competences on a five-point scale – value from 1 (excellent preparedness) through 5 (lack of preparedness). A total of 710 questionnaires were sent out by electronic e-mail from the 6th to the 20th of May 2011 and 64 useable responses were obtained, representing rate of 9 %.

4.1. General Background

Most respondents (61 %) were male from the manufacturing enterprises. The majority respondents (45 %) were general managers, followed personnel manager (11 %); project manager (8 %); production manager (3 %); IT manager (2 %) and 31 % respondents worked on other jobs. Thirty-seven percent of respondents worked in the micro-enterprises, followed small enterprises (20 %), medium enterprises (13 %) and large enterprises (13 %). More than 45 % respondents were from the enterprises existing on the market from 11 to 20 years; followed enterprises from 6 to 10 years (23 %); enterprises older than 30 years (19 %); enterprises from 0 to 3 years (7 %); enterprises from 21 to 30 years (5 %); enterprises from 4 to

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[2] IPMA® and ICB® are registered trademarks of the International Project Management Association® in Switzerland and other countries.

5 years (3 %). Most respondents (91 %) were participated in carrying out projects.

4.2. Project Management Competences - Differences between Respondent Groups

Mainly business managers worked in the **micro-enterprises**. The most of the micro-enterprises existed on the market from 6 to 10 years and from 11 to 20 years and 88 % respondents worked on the project. The employees worked on project – the processes management, such as leading people. They had a space to develop their competences, but had no interest or time to use it. The micro-enterprises unused or little used methods for assessing workers' competences and competences used only at the average readiness level. Competences, such as leadership and personnel management were under-prepared.

Small enterprises employed a majority of business managers; economic managers and sales managers and had the same research results as micro-enterprises in the length of their existence on the market; in the use of competences and methods of assessing competences. As for the space to develop their competences, the results were different. Employees were to some extent influenced by the instructions of their superiors, workload and busy. Nevertheless, they found those who would like to develop their competences. Small enterprises were the worst in the use of readiness competences.

In **medium enterprises** was able to find jobs like business manager, followed personal managers, production managers and IT managers. Medium enterprises were no different from small and micro enterprises in the length of existence on the market and work on projects. The using of competences in the field of process management and leading people have been balanced and approximately the same with the use of space for competences. In medium enterprises the most used methods to assess competence, especially standardized structured in-depth interviews and modelling solution. Interest of employees in medium enterprises to develop their competences was greater than in micro and small enterprises. Readiness in the use of competences was at a sufficient level to average level. The competences, such as communication; cooperation and problem solving were the lack of readiness.

Most personal managers and production managers worked in the **large enterprises**. Length of existence on the market was older than 30 years and worked on the projects. Competences, which they used, would not been included into the process control or leading people. Employee in develop of competences in addition to regulations hindered their personality, workload. Large enterprises did not use extensively competencies assessment methods and modelling situations. Readiness to use the competences was at a sufficient level to average level [6].

4.3. Hypothesis Testing and Evaluation

Based on the above problems have been formulated several hypothesis. Two of them focused on the impact of enterprises size on the development of competences of project managers in selected enterprises and their evaluation:

H1: **There is dependence between enterprise size and the space for employees to develop competences**.

H2: **There is dependence between enterprise size and use of methods for assessing competences**.

For the evaluation of hypotheses was used Pearson's chi-square test. The results of chi-square test of independence were gained from the online calculation [3, 6]. The significance level (α) is chosen to be 0.05 (or equivalently, 5%). If the probability value (p-value) is less than the chosen significance level then we reject the null hypothesis, i.e. accept that sample gives reasonable evidence to support the alternative hypothesis. Before the testing of hypothesis it was necessary to establish Pivot Table, which consisted of research results of the questionnaire – questions No. 2, No. 8 and No. 14.

Calculated probability was compared with the level of significance, then $0{,}06052333 \geq 0$; and $0{,}09107101 \geq 0{,}05$ [3, 6].

In both cases, the outcome of a hypotheses test is "Reject H0 in favour of H1". This means, there is a relationship between enterprise size and the space for employees to develop competences and between enterprise size and use of methods for assessing competences.

5. CONCLUSIONS

The discipline of project management has come of age. While the body of knowledge is well defined, in many enterprises there remains a serious gap with the issue of the appraisal of the competence of project personnel. Responsible practice requires that this gap be eliminated. Doing so will help improve corporate performance, reduce shocks at boardroom level and avoid hardship to stakeholders. This paper was aimed at the current state of competencies development of project managers in selected enterprises in Slovak republic - mainly in manufacturing enterprises. The paper was established on the understanding the role of project managers (especially role of persons working on the project) on dependency from the enterprise size. The research established that the knowledge and skills necessary to maintain their competency, in order to full these changing demands are acquired largely from their experiences.

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A Rich and Versatile Tourist Offer as a Receipt for Tourism Competitiveness and Success

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Abstract

The Brod-Posavina County still has not established an identity that would make a modern and highly recognizable tourist destination. In order to achieve higher efficiency in this effort, it is necessary to adopt a segmented approach while determining those market segments which will require a separate marketing strategy and create a distinct image of the destination. By making an assessment of the achieved level of development of key factors for tourism development a competitive ability of the county has been evaluated. In that way, an ideal state of tourist offer that should be strived for and that would generate a maximum tourism competitiveness (comparing to those tourist destinations which still haven't reached the highest level) has been defined. The survey is based on the method of analysis and synthesis, classification, generalization and specialization. This paper provides guidelines for building a well-rounded and competitive cultural tourist offer, designed for both domestic and international markets.

Keywords: Tourist destination; Competitiveness; Positioning; Strategy; Elements of the supply.

1. INTRODUCTION

Cultural assets and their adequate protection are of special importance for tourism development. By its regional plan a Brod-Posavina County is defined as a protected urban area with a number of monumental complexes, individual sites and buildings. In that sense, a strategic marketing plan for tourism development with a view to create some new tourist products. Furthermore, some other special projects for individual tourist sites should be done, so that tourist offer of each site can be differentiated.[1] A policy for tourism development is implemented into a Master Plan for tourism development. According to this Master plan, Slavonian mountains, plains and the valley of the Sava river, traditional folk heritage and wine and gastronomy make firm foundations to build a tourist market on.[2] Tourism development of the Brod-Posavina county was also determined by the Tourism Master Plan for the city Slavonski Brod 2010-2020. This Master plan is a framework for coordinating and managing activities of various economic operators, public sector institutions and of all other subjects that are directly or indirectly involved in developing and raising the overall quality of the city's tourist product by the year 2020.[3] Creation of an ideal tourist offer finds its framework within all of these three documents, and its success will be ensured only by using a segmented approach while determining those market segments that will define specific marketing strategies and form a distinct image of the destination.

2. TOURISM OF THE BROD-POSAVINA COUNTY

Favourable geographical position of the Brod-Posavina County, its rich cultural and historical heritage and a highly professional hospitality industry enable the development of selective forms of tourism, such as transit, hunting, fishing, rural, wine, culinary and cultural tourism. With its landscapes and excursion sites full of various plant and animal species, this county attracts many visitors to see and explore its protected natural areas. There are opportunities for active holidays on bike paths, while rich forests and water resources are good for the development of hunting and fishing tourism. A wide selection of authentic cuisine and high quality wines, traditional hospitality of the people, a number of cultural activities and events, and cultural heritage – altogether they form solid foundations for the development of cultural tourism. Basic resources of the cultural tourism are the county's cultural heritage, cultural and religious institutions, events, famous people and events, and the culture of living and working. These resources should be, however, adjusted to global trends in a creative way so that they can coordinate with local, regional and national capacities in the formation of innovative products in cultural tourism.

2.1. Cultural and historical heritage

City's Fortress, as a monument of the highest category, is among the largest fortification monuments not only in Croatia, but also in Europe. Apart from this architectural heritage, there is also the old town of Slavonski Brod, with a Franciscan monastery and church of the Holy Trinity in Slavonski Brod, a Franciscan monastery and the baroque church of St. Peter the Apostle in Cernik, Parish Church of St. Stephen the King in Slavonski Brod, church of St. Anthony of Padua in Podvinje, and St. Theresa's church in Nova Gradiska, all of them providing several preconditions for the creation of tourist demand.

2.2. Cultural and religious institutions

Several well-organized cultural institutions are the "soul" of county's cultural life. Theater-concert hall "Ivana Brlić Mažuranić ', Art Gallery, Gallery and Museum "Ivan Mestrovic" in Vrpolje are institutions whose activities are extremely valuable for creation of a series of complementary programs and products.

2.3. Events

There are many manifestations of cultural or entertaining character with a view to improve and promote cultural and social life of the county. Such events are: *In a Fairyland of Ivana Brlić Mažuranić* and the folkloric festival "*Brodsko kolo*".

2.4. Famous people and events

Famous people and historical events represent an inspiration for festivals and events. Several important names of Croatian art are associated with the Brod-Posavina County, such as writer Ivana Brlić Mažuranić, poets Dragutin Tadijanović, Grigor Vitez and Tito Bilopavlović, educator and writer Matija Antun Reljković, sculptors Ivan Mestrovic and Branko Ruzic, painter Vladimir Becić and ballet dancer Mia Corak Slavenska.

2.5. Culture of living and working

Culture of living and working can be the basis for the creation of touristic manifestations and destination's souvenirs. It combines folklore, handicrafts, traditional construction and landscaping, traditional crafts, wine and gastronomy, the tradition of hospitality and contemporary production. It is necessary to recognize the importance of these elements and to encourage initiatives and projects in the domain of their research, presentation and nurturing.

3. TOURIST DEMAND FOR CULTURAL TOURISM PRODUCT

Generally speaking, people who visit cultural and tourist attractions and events in the continental part of the Croatia are on average between 38 and 40 years of age. These are mostly local visitors from neighboring counties (67%). Half of them are tourists that from place of their residence (49%) go on a one-day trip (54%). When it comes to longer trips, those lasting up to three days are prevalent (29%). 44% of visitors are staying at their relatives and friends, and 27% in hotels. The average daily consumption amounts 65 euros. [4] With some minor variations, the same can be applied to the visitors of Brod-Posavina County.

3.1. Promotion of the cultural tourism product of Brod-Posavina County

Brod-Posavina County is rich in resources. Development of cultural tourism should be based on the current state of cultural resources and attractions and on ability to receive visitors and, consequently, on willingness to organize promotion at the tourism market. Apart from well-organized distribution channels, a key to the success of a cultural tourism product lies in its creation and promotion. In addition to cultural and tourist attractions, the main agents of the promotion of cultural tourism products are Tourist Boards of Slavonski Brod and Nova Gradiska. Current cultural tourist offer of Brod-Posavina County is not in accordance with its actual development potential. For this potential to be realized, it is necessary to prepare attractions and resources for a visit, so we talk about the level of market's readiness. Prepared are those attractions that are physically and timely available, have an organized guided tour and adequate promotional material. The encouraging fact is that the county's holders of public authority have recognized this potential of tourism. Evident are also a great number of manifestations, festivities, cultural events and entertainment programs that will make this area market-distinctive, in a relatively short period of time, particularly at the domestic market.

4. SHAPING THE IMAGE OF THE DESTINATION

The Brod-Posavina County has not yet developed a strong identity that would make it a distinctive destination within a large tourist market. To achieve higher efficiency in this effort, it is necessary to apply a segmented approach to identify those market segments that have similar needs, so that specific marketing strategies can be determined and a specific image of the destination can be formed. For this purpose it is necessary that many, mutually complementary, elements of tourist offer are arranged in an appropriate manner. To ensure a long term sustainable competitive and successful positioning, it is necessary to make decisions (which should be based on a realistic assessment of the advantages and disadvantages of destination in comparison with major competitors) about the most important target markets and what products/services are the most important ones. In the end, it is possible to develop a favorable image for the promotion of the county. Positioning, while focusing on specific destination attributes, provides a mechanism for making decisions that improve the effectiveness of external marketing functions and lead to an internal development of the brand.[5] Brod-Posavina County has several comparative advantages. Basis for tourism development should be directed towards cultural tourism, especially towards cultural heritage and tourism events. Focusing on urban tourism finds its foundations in the concentration of historical monuments, various events, artistic performances of entertaining and/or economic character, as well as in many other diverse activities that may be the main destination of travel or just casual stopping points. Slavonia is a popular destination for wine tourism, and within the last decade, it has become an increasingly popular form of tourism of special interests. With regard to the wineries in the vineyards of Slavonski Brod and Brodski Stupnik, as well as the relatively near Kutjevo vineyards, this could be an interesting product. It is necessary to encourage the consumption of locally grown food, not only at agri-tourism farms, but also in restaurants and other catering establishments of the county. Demand for rural tourism is, in most cases, generated mainly by domestic tourists, although it can be noted that rural destinations attract an increasing number of foreign visitors. That is why it is extremely important to encourage a competitive tourist offer on the farms and creation of various entertaining, recreational, educational and gastronomic activities and contents. The demand for tourism based on the use of natural resources makes 7% of world tourism demand[6], and the motives of these tourists are striving for a healthy life and being in nature, recreation, rest and mental relaxation, but also the pursuit of new adventures and new challenges generally. Brod-Posavina County is full of local and county's bike trails, some of which are part of the regional cycling routes.

5. CONCLUSION

With development of well-defined and well-designed cultural tourism products, Brod-Posavina County could gain a status of a cultural tourism destination. Development of tourist products, whereat tourist entrepreneurs and cultural workers are together trying to design and offer products that will correspond to the market requirements, will make these efforts worthwhile for the entire county and region. Development of an overall strategy that will enable positioning of the county as a cultural tourism destination is a step that should follow. Brod-Posavina County has to define its vision, goals and concepts of tourism development on its area. To succeed in this effort, cultural tourist offer of the county should be improved, new products need to be developed and the focus should be on new market segments, so that tour operators include these attractions into their routes and make this beautiful area available to their customers. In the postwar period, Brod-Posavina County was trying to establish its position within the tourism market. Without a fixed identity and as a mixture of many resources and different kinds of tourism, it is necessary for the county to redefine its image and to put stronger emphasis on the culture as its main resource for (re) construction of an image. Development of a distinctive cultural tourism product in the Brod-Posavina County would encourage the rapid development of image and identity of the county as a tourist destination, which is reason why cultural tourism (along with other forms of selective tourism) should be included in development plans at all levels - counties, cities and towns.

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The impact of fair value measurement on the enterprise's costs

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Abstract

In financial accounting, there are two important moments when assets and liabilities need to be measured: on initial recognition and at a balance sheet day. Many International Financial Reporting Standards used the fair value measurement. Standard 16 is one of those that provide the possibility to measure the assets at fair value as of the balance sheet date. The objective of this article is to give a brief overview of the possibilities of using the fair value according to this standard.

Keywords: Fair value measurement; Financial accounting, assets; Cost model; Revaluation model.

1. INTRODUCTION

Measurement of assets in financial accounting is extremely complex and it can be stated that it represents the basic problem of accounting, which determines the content and the explanatory ability of the financial statements. The main issue of the measurement in financial accounting discussed at present is: using the fair value measurement in revaluation model at a balance sheet day for tangible fixed assets under IAS 16 Property, plant and equipment.

IAS 16 Property, plant and equipment (PP&E) provides for accounting and reporting of TFA, which IFRS defines as owner – occupied property. According to this standard, the property, plant and equipment are tangible items that: [1]

a) are held for use in the production or supply of goods or services, for rent to others, or for administrative purposes; and

b) are expected to be used during more than one period.

PP&E are recognized as assets if they meet the definition of assets, as set out in the Framework: [1]

- it is probable that future economic benefits associated with the item will flow to the entity; and
- the cost of the item can be measured reliably.

In financial accounting, there are two important moments when *PP&E* need to be measured:

a) on initial recognition: an item of *PP&E* that qualifies for recognition as an asset shall be measured at its cost.

b) at a balance sheet day: An entity shall choose either the cost model or the revaluation model as its accounting policy and shall apply that policy to an entire class of *PP&E*.

Cost model

After recognition as an asset, an item of *PP&E* shall be carried at its cost reduced by any accumulated depreciation and any accumulated impairment losses. This model is based on the principle of the evaluation of assets at the moment of acquisition and does not respond to fluctuations in the price level upwards. Here we can copy the asset price developments only downwards under IAS 36 Impairment of Assets.

Revaluation model

After recognition as an asset, an item of *PP&E* whose fair value can be measured reliably shall be carried at a revalued amount, being its fair value at the date of the revaluation reduced by any subsequent accumulated depreciation and subsequent accumulated impairment losses.

If an item of *PP&E* is revalued, the entire class of *PP&E* to which that asset belongs shall be revalued.

If an asset's carrying amount is increased as a result of revaluation, the increase shall be recognised in other comprehensive income and accumulated in equity under the heading of revaluation surplus. However, the increase shall be recognised in profit or loss to the extent that it reverses a revaluation decrease of the same asset previously recognised in profit or loss.

If an asset's carrying amount is decreased as a result of revaluation, the decrease shall be recognised in profit or loss. However, the decrease shall be recognised in other comprehensive income to the extent of any credit balance existing in the revaluation surplus in respect of that asset. The decrease recognized in other comprehensive income reduces the amount accumulated in equity under the heading of revaluation surplus.

The effects of taxes on income, if any, resulting from the revaluation of property, plant and equipment are recognised and disclosed in accordance with IAS 12 *Income Taxes*. [1]

2. MEASUREMENT METHODS FOR PP&E UNDER IAS 16

Each of the measurement methods, under which PP&E are measured at balance sheet day, has its strengths and weaknesses, and companies have the right to choose a particular method.

Despite the fact that the revaluation model is used in practice less than the cost model, it is interesting to analyse and assess the differences that this model offers in comparison with the cost model.

2.1. Comparison of cost model and revaluation model for PP&E

On model examples we are going to point out the application of cost model and revaluation model for *PP&E* at a balance sheet date. We are also going to show and compare that the different measurement methods for *PP&E* impact on costs and profit/loss of the enterprise by accounting deprecation. We will not consider all costs and revenues generated by the company during each year, but we will focus only on the costs in the form of deprecation.

Model example 1 – *The application of cost model on a balance sheet day.*

On 1/1/2011 company purchased asset for 4 000 000, estimated its useful life to be 25 years, salvage value of 0 and selected straight-line depreciation. The company plans to achieve sales of 1 000 000 a year. In this example, we do not consider the tax depreciation and deferred income taxes.

Table 1 shows the calculation of depreciation and its impact on profit/loss over five years, if the asset is measured at the cost on the balance sheet date and company plans to achieve sale of 1000 000 a year.

Table 1. The effect of depreciation on profit/loss in the cost model

Years	Gross value of asset	Cost - depreciable amount	Sales	Profit/ loss
1.	4 000 000	160 000	1 000 000	840 000
2.	4 000 000	160 000	1 000 000	840 000
3.	4 000 000	160 000	1 000 000	840 000
4.	4 000 000	160 000	1 000 000	840 000
5.	4 000 000	160 000	1 000 000	840 000

The amount of depreciation is the same throughout the life of the asset if the enterprise applies the cost model, i.e. cost of an asset is transferred to income statement the same amount each year.

Model example 2 – *Application of revaluation model to balance sheet day.*

The company decided to apply the revaluation model for asset, the residual value of which as of 31/12/of the second year is 3 680 000. The fair value of the assets as of that date is 3 900 000.

Table 2 shows the calculation of depreciation, its impact on profit/loss over five years, if company plans to achieve sale of 1000 000 a year. When revaluation of assets to fair value is applied, depreciation of these assets is charged to revalued amount. The depreciation charge for each period shall be recognised in profit or loss.

Table 2. The effect of depreciation on profit/loss in the revaluation model.

Years	Gross value of asset	Cost - depreciable amount	Sales	Profit/ loss
1.	4 000 000	160 000	1 000 000	840 000
2.	4 000 000	160 000	1 000 000	840 000
3.	3 900 000*	169 565	1 000 000	830 435
4.	3 900 000	169 565	1 000 000	830 435
5.	3 900 000	169 565	1 000 000	830 435

**At the end of second year, the asset was revalued to fair value to 3 900 000. This value will represent gross value of assets in third year, and this value will be calculated depreciation for the remaining useful life of 23 years.*

When comparing the effect on profit/loss in fig. 1 it is evident that if the company increases the value of asset to fair value, it has lower profit/loss than in the application of the cost model. This is due to the fact that the depreciation in the period after revaluation is determined by the revaluation of a revalued amount.

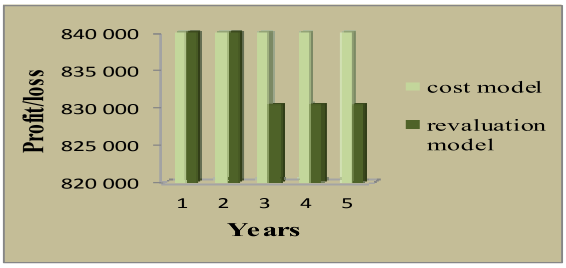

Fig. 1. The Profit/loss in the application of both models

On model cases, we pointed out how both models affect the amount of cost and profit/loss. The above examples show that if the company applies the revaluation model and increases the value of assets upwards, it reports lower profit than if it applied the cost model. It is important to mention that this measurement models affect the reported amount of assets and equity and in the case of the revaluation of assets upwards may lead to the improvement of the financial situation.

2.2. The impact of the application of measurement methods on financial ratios

Financial ratios are useful indicators of company´s performance and financial situation. Most ratios can be calculated from the information provided by the financial statements. Financial ratios can be used to analyse trends and to compare the company´s finance with other enterprises. In some cases, ratio analysis can predict future bankruptcy. [2]

For the model examples, we also selected ratios that are mostly affected in terms of alternative measurement of TFA. For the calculation of these ratios, we used data from the previous examples. The calculated values of these ratios for the first, third and fifth years are shown in table 3.

Table 3. Selected financial ratios

Ratio	Cost model			Revaluation model		
	1.	3.	5.	1.	3.	5.
Return On Sales (net profit/sales)	0,84	0,84	0,84	0,84	0,83	0,83
Effectiveness of property (sales/carrying amount of property)	0,26	0,28	0,31	0,26	0,27	0,29
Deprecation to sales ratio (deprecation/sales)	0,16	0,16	0,16	0,16	0,17	0,17

From the point of view of the impact on the financial situation of the enterprise, the application of cost model seems to be more positive, if the company wants to achieve a higher amount of return on sales and effectiveness of property during useful life of assets. These values of financial ratios will be higher because the company reports lower depreciation and carrying amount of property than at the revaluation model.

When the company applies the revaluation model, it must calculate with lower amount of return as if the asset was revalued to fair value upwards. However, there may be companies, which comply reporting of lower profits, for example in order to obtain higher state subsidies or because of lower dividend payments and etc.

3. WHO USES FAIR VALUE MEASUREMENT FOR PP&E UNDER IFRS

Fair value measurement has its proponents and opponents at present. Proponents argue: “reporting kept in fair value measurement is consistent. This reflects the impact of inflation and changes the price level. Thus determined values are objective and reflect the true value of the property“. [3] Opponents argue: „fair value accounting or fair value measurement withdraws from the precautionary principle and realization principle. Such valuation leads to an overstatement of assets and produce artificial wealth effect“. [4]

Based on these arguments and its negative impact on profit/loss, we surveyed users of fair value measurement for PPE in practice. In analysis we used the 25 consolidated financial statements prepared under IFRS. The results of the analysis are shown in table 4.

Table 4. Enterprise measurement practices

Industry name	Sample	Fair value measurement for PP&E
Apparel	1	1
Automotive	1	0
Beverages	2	0
Chemicals	2	0
Construction	1	0
Drugs, Cosmetics & Heat care	1	0
Industry name	**Sample**	**Fair value measurement for PP&E**
Electrical	1	1
Food	2	0
Machinery & equipment	2	0
Metal producers	1	0
Oil, gas, coal & related services	6	1
Paper	1	0
Tobacco	2	0
Other industries	2	0
Total	**25**	**3 (12%)**

Given the result of analysis, we think it is necessary to ask nowadays: What is the reason for the application of fair value measurement for PP&E? How are the companies going to handle the costs connected with the annual assessment of the carrying value of assets? Are these costs included in the calculation of the costs of own performance of the enterprise, and thus the source of the increase of prices of manufactured products? Is fair value of these assets really objective and does it reflect the changes of prices?

4. CONCLUSIONS

The measurement process can be regarded as one of the most important areas of accounting, given its importance in presenting and assessing the economic situation of the enterprise. IAS 16 provides two possible solutions for the measurement of *PP&E* on the balance sheet date - the cost model and the alternative - the revaluation model. The use of measurement models for *PP&E* provides various information of costs, profit/loss of enterprise and different amounts of financial ratios.

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Performance Management – Prerequisite of Industrial Enterprises Sustainable Development

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Abstract

Contemporary conditions for operating industrial enterprises are remarkably influenced by wide changes in society, such as political and economical integration, internationalization, business and production globalization and the process of ecologization, etc. The mentioned conditions, multiplied by a world-wide economic crisis totally evoke new conditions for industrial enterprises. To react properly to the above changes and maintain sustainable entrepreneurial development it is necessary to optimize their performance by clear unambiguous concepts. One of the possibilities is to create performance management model to maintain the sustainable development.

Keywords: Management; Performance; Model; Employees; Competitiveness.

1. INTRODUCTION

Contemporary period of turbulent changes in all areas of social life influenced by globalization and world economic crisis create totally new conditions for operating industrial enterprises. To react properly to the above changes and maintain the enterprise sustainable development it is needed to optimise the enterprise performance. Looking at long term point of view, the key factor of enterprise performance optimisation in the mentioned conditions is to reach the demanded (not maximised) level of employee performance as well as to maintain it.

As far as demanded level of enterprise performance sustainability it is required to manage it systematically. Due to the changes of enterprise conditions and the employees themselves as well (different values and needs, the necessity to actively engage into the enterprise actions) it is crucial to change the approach to employee management and performance management. This was the reason to suggest employee performance management (thereinafter EPM model) which could become managerial tool to improve employee performance and also the overall enterprise performance.

2. EMPLOYEE PERFORMANCE MANAGEMENT

The key terms were defined in this particular area (work performance, work efficiency, employee performance management) for research needs carried out in industrial enterprises operating in middle Europe in 2010 – 2011 [1] as well as for EPM model development which followed the research.

Inspite of the fact that the authors are not uniform to explain the term „performance" (in connection with human resource management we speak about "work performance") it is possible to declare that there exists in professional literature consensus. The **work performance** depends on two basic essential factors: employee personal assumptions and technical and organizational conditions under which work is progressing. The new concepts of human resource management understand work performance not only as a result of employee's activity, but they also study how *competencies* and particular *behaviour* of each employee is affecting their work [2].

It means that the concept of work performance refers not only to the amount and quality of work, but also to willingness, approach to work, work behaviour, frequency of accidents at work, absence, relationships with people in connection with work, etc. Work performance is here understood as a result of interconnection and mutual relation of employee’s competencies, effort and understanding of a given task [3]. It is important to become aware of the fact that the stated attributes of employee considerably depend on his manager (competencies: selection and following development; effort: motivation; task understanding: management style and communication).

Concept of **work efficiency** presents long-term expression of work performance concerning particular employee.

Employee performance management is a constant, continuous process of identification, evaluation and development of individual efficiency of employees, in accordance with the strategic goals of an enterprise [4], [5].

Main goal of employee performance management is to reach long-term success of an enterprise on the market and have successful and satisfied employees who perform their work efficiently and are competent and focused on reaching the particular result. Performance management is focused on fulfilling the goals and minimizing the useless outputs. To reach high efficiency, it is important to set the ratio of useful and useless outputs. If an employee is highly efficient as an individual, but he reaches higher ratio of useless outputs, he becomes inefficient for the enterprise and from the point of view of the enterprise, he only reaches the low level of performance.

3. EMPLOYEE PERFORMANCE MANAGEMENT MODEL

While creating the employee performance management model, it was necessary to set and define the key features of EPM model and the activities that „take place” between these features.

3.1. EPM model features

EPM model features are:

1. employee,
2. manager,
3. top management.

Basic feature of EPM model is an **individual employee** with his abilities, knowledge, personal characteristics, attitudes, self-motivation, effort to work and willingness to deliver certain performance. To make the model work properly, it is necessary to identify determinants affecting the performance of a given employee.

Second feature of EPM model is a **manager.** Employee performance and so the performance of the whole enterprise (as stated above) is significantly dependent on the efficiency of his work.

Third feature of EPM model is **top management** of a given enterprise. Top managers participate in creating of values, they affect the atmosphere and running of the enterprise as a whole, and create conditions to fulfil its strategic goals. Attitudes at lower levels of management also arise out of the attitude of top management.

3.2. Activities within the frame of EPM model

As the key activities within the frame of EPM model, the following points have been set:

1. planning of performance,
2. monitoring of performance,
3. performance appraisal.

Planning of performance

Starting point of EPM cycle is planning of employee performance, which includes discussion and following agreement between the manager and the employee on future expectations at work and required behaviour of the employee towards his environment. Goal of this phase is to reach an agreement on responsibilities of the employee and the manager in task performing for the following period.

In this phase of EPM model, it is important to process the plans of employee individual development, hold talks between the manager and the employee mainly on the setting of particular performance-related goals concerning the employee in dependence on the goals of the enterprise, defining its key responsibilities while reaching these goals, possible risks and restrictions, possible cooperation with other subjects within the enterprise and beyond, criteria of individual tasks appraisal and the way of feedback providing.

Monitoring of performance

Employee performance monitoring is a complex of activities which enable performing of tasks regulation in the required direction. It is the monitoring not only on the part of the manager, but also the employee to „keep" his performance. Above all, managers should give feedback, communicate with the employee about task solutions, and identify uncertainties, barriers to perform tasks, express support, and help with the changes that may occur during the task performing.

Performance appraisal

In this phase of EPM, there is a complex appraisal of employee's work and his behaviour during the course of the monitored period. It is usually a formal dialogue between the employee and the manager that is specified by certain rules. Result of this dialogue is usually presented as setting the employee's individual development plans for the following period, proposal for the compensation packages change, identification of the employee's potential, eventually proposal for further career advancement. Output is the document, signed by both parties, that summarizes the agreed conclusions.

3.3. EPM model

Basic features and activities of the performance management process meet together in one place, certain time and space. Their relationships and inter-connections lead to mutual compilation and EPM model design (Fig. 1).

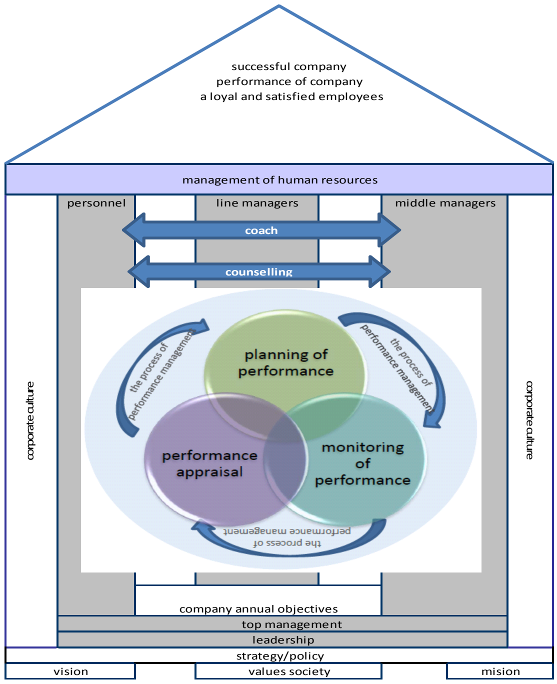

Fig. 1. EPM Model [1]

In every enterprise, it is necessary to form the base of EPM model by its *values, vision and mission.* Stated attributes are set and defined by the owner of the enterprise and *top management* is responsible for their real fulfilling. Pillars of this model are *employees, line and middle managers. Corporate culture* makes space for realization of individual phases concerning the performance management process and inter-connections between the features. „Roof covering" of this model is presented by the activities of *human resources management* through which the performance management process results „flow".

Inside of the model, there are features which directly relate to each other and interact. There is a principle saying that the behaviour of top management reflects in the behaviour of lower levels of management, as far as the employee. Top management creates the corporate culture as a strategic tool to reach the required performance and so fulfil the strategic goals of the enterprise [6] Line managers are responsible for fulfilling of the goals and performing of the tasks that have been set by their organization. Performance of „own" employees can be influenced by e.g. *couching and counselling.* Employees have their own performance level that is influenced by external and internal factors.

3.4. Conditions of EPM model effective application

Following the results of the above mentioned research, it is possible to say that enterprises usually know and perform the activities that come under EPM process. However, the interconnections between them are not carried out explicitly and they are not utilized as complex. Condition of enterprise success is the application of all features and activities defined in EPM model. For this reason, the conditions of EPM model effective application have been formulated:

Holistic approach application is needed in employee performance management.

For each enterprise, it is necessary to work out specific EPM model.

Enterprises need to define value pillars that create enterprise culture and enable managerial decision-making.

Employee performance management needs to be applied in the management of all employees in the enterprise.

Work out and following keeping of the communication plan to implement the model.

Understanding of EPM conception as an integration process.

4. CONCLUSION

In practice of industrial enterprises it is possible to observe the increase of application of differently created EPM models. Their application often leads towards permanent overloading of particular group of employees. Thus overloading primarily threatens the health (mental and physical) and so the performance of employees themselves. Finally, from the long term point of view the performance and competitiveness of enterprises is threatened. This was the reason why our aim of this contribution was to highlight the need of new approach towards employee performance management.

5. ACKNOWLEDGEMENTS

This contribution has been developed under the project No. 1/1059/11 "The barriers of knowledge gained at universities versus entrepreneurial environment".

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Managing changes in the lifecycle of the project

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Abstract

This contribution introduces recommendations how to approach changes during managing the project. It analyzes their predictions and incorporating them as a vital part of the life cycle of projects. At the same time, it presents the results from already realized research within own upcoming thesis between organizations in project management in Slovak as well as Czech Republic. In real conditions, it is necessary to focus specially on managing changes because there can be found many risks witch guide changes and can be overcome only by the active management of changes. The emphasis focuses on understanding to the result of each change.

Keywords: Changes; Project management; Life cycle.

1. INTRODUCTION

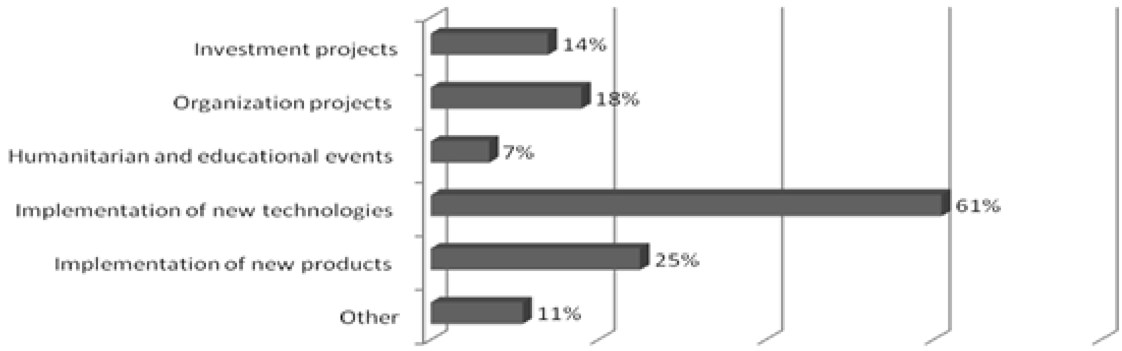
In present time, project managements is considered as inherited tool which is used for reaching goals and objectives of own organization. Organizations meet with the problems for example how to successfully realize wide and complex projects. Moreover, they try to insure that their effort will be given into projects that are in progress. The successful growth depends on ability of the organization as well as on faster improvement and extension of own products as an answer on customer's demand. Currently, **the experience shows that on the market demand for the fastest development dominates the temptation that treat processes and tools for managing changes as an unnecessary overhead, which slows the development.**

Managing changes is an investment without any plans, processes or information systems through which all projects might be managed instead of very small and simple ones. Projects expose the risks of losing control over the given project and exceed the time limits for the project and further threats related to the project.

Changes come into the project of product's development in each part of the life cycle based on specification of requirements through the implementation, testing, integration, deployment and maintenance. Their importance and mainly their own impact are not same in single parts of products life cycle. For example, changes that specify requirements have impact on all following developments phases. However, the impact of changes in implementation phases does not have to exceed the area of implementation module.

Risks that accompany the changes can only be overcome by an active management of change. This offers the possibility to avoid any uncertainty which may have a negative or a positive impact on achieving the objectives of the project. Due to the unique character of projects, such risks become a part of each ones and therefore it is necessary to understand to the consequences of any change, which the project requires:

1. to know the changes, which might appear as well as whole area of change in the project,
2. to estimate consequences of each proposed change,
3. immediate communication of each change with everybody who are involved into it.



Graph 1. Distribution of projects by type - histogram [own source]

When companies try to reduce the development cycle of technology or products while keeping up with the new ideas and development of user's requirements, then the changes might appear as an enemy of rapid development. This combination of complexity, speeds development cycles and transmission of system and rapid change creates main risks of product development. In order to keep the pace with the competition, the change must be taken as a factor that needs to be managed in same way as technology, resources and time.

People can imagined the management of change as a closed system with feedback, which in the real time is adapting to changing inputs and reported objectives. Feedback includes all the changes that occur in the system and their impact on the system.

Ways of the design proposal for any change are well known and widely discussed in the literature, but it should be mentioned that it was perhaps more discussed than used. For any project, it is not able to predict what is going to be wrong. Still, something will go wrong, definitely wrong.

2. QUESTIONARY – RESEARCH

Relatively interesting results have come up from an actual research within own upcoming thesis "Complex audit of project management," into which were involved organizations with an extensive experiences in project management within Slovak and Czech Republic.

Some interesting results related to this contribution are sum up in following answers:

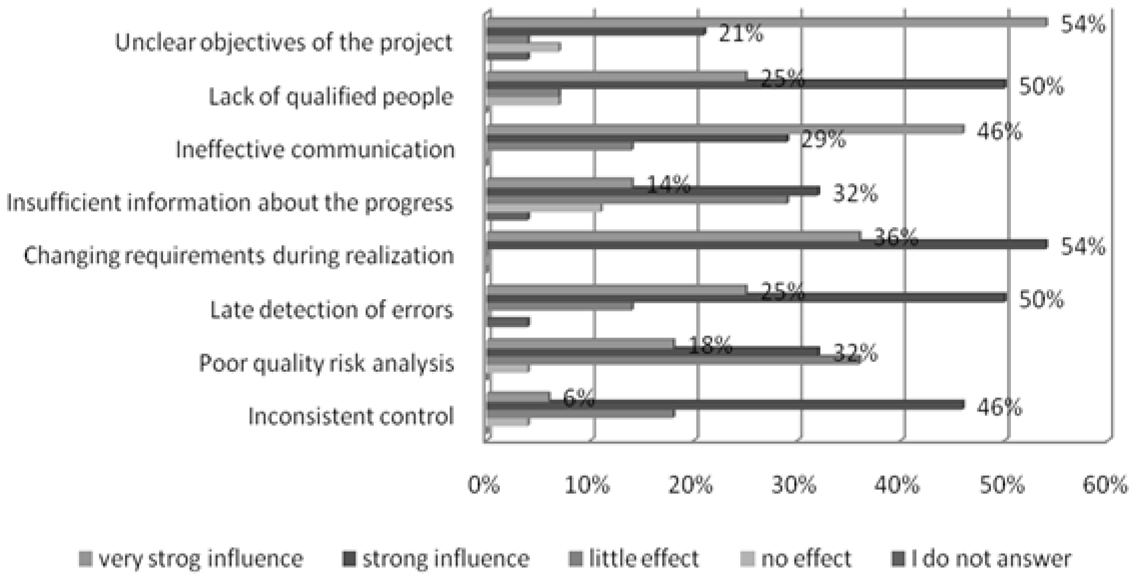
In terms of respondents profile was obtained totally 106 answers, from which 72% of respondents were Project managers who were responsible for project delivery. 7% of all were top managers, and then 21% creates members of project team. It has to be also mentioned, that majority part of researched projects is or was realized project and its realization usually takes from 6 to 12 months on an average budget of implemented projects in 39% what is around 100 000 – 1000 000 Eur.

Whereby about 29% from asked people could not or did not want to answer and publish an average budget of project because of the agreement terms and conditions.

As is clear from respondent's answers in chart 1, 61% of respondents reported that currently, they are most engaged in implementation of projects that introduce new technologies.

The most significant feature of the evaluated survey connected to this contribution issue is the perception of the need for effective change of each management projects. Moreover, according to defined rules, its management was confirmed only by 57% of respondents of surveyed organizations. Even though, that the organization which was surveyed are organizations with broad experiences in project management dealing with the large projects, it is a low percentage.

Also other graph 2 can be considered as very interesting ones because for example the Graph 2 focuses on impact in case of project failure. The impact on project failure is perceived by 36% of respondents in the form of poor quality risk analysis. They consider this type of risk as not too significant. Late detection of errors in



Graph 2. Causes of project failure – histogram [own source]

already completed projects and their impact identified by 75% of respondents and so on. Failure of the project itself was found out in 43% of the assessed organizations during the project. However, it should be noted that 32% of respondents did not know to answer the given question.

3. CONCLUSION

A well-functioning process of managing changes in the project means that even if the life slightly complicates it, it will be beneficial for all that is interested into it. In real conditions, it is necessary to deal with the area of management changes whereas the risks that accompany the changes can be overcome only by the active management of change. The emphasis focuses on their predictions, incorporation, and managing during the life of the product as well as on understanding to the implication and consequences of each change. Anticipating changes is not easy, because there are many reasons why the project can or should change.

It has to be said that in the second quarter of 2011, it is the industry that suffers from weaker exports throughout whole Europe and not just in Slovakia, where is a decrease of 4%. As the financial analyst Danco mentioned, the computer production, electronic consumption, machine industry and still failing building industry are most involved. So, economists are waiting how the current uncertainty in the markets will reflect the industry and how it will influence it.

4. ACKNOWLEDGEMENTS

The contribution was created within the project VEGA 1/0491/09.

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Regional differentiation in organization and levels of financing, volumes and levels of people satisfaction from medical care quality in Russian Federation

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Abstract

In this article we attempted to analyse differences in organization and levels of financing, volumes and levels of people satisfaction with the medical care quality in regions of Russian Federation. We tried to define the position of Republic of Bashkortostan in the space of indexes, indicated main properties of regional healthcare systems. Input data for the analysis were the analytic review of the implementation of Programme on State Guarantees (PSG) to Deliver Free Medical Care to the Citizens of the Russian Federation in 2008, published on the official site of Ministry of Health Care and Social Development of the Russian Federation, and data of the survey «The research of the people opinion about an availability and a quality of the medical care», passed in 2008 by Federal Health Care and Social Development Inspection Service.

Keywords: Healthcare system; Regional differentiation.

1. INTRODUCTION

There are essential regional differences in the budgets and fund rising of healthcare systems, extents of medical aid, levels of medical attendance between subjects of the Russian Federation.

The purpose of this work is defining the position of Republic of Bashkortostan in the space of indexes, indicated main properties of regional healthcare systems.

Next objectives were resolved in the process of working:

1. Positioning of Bashkortostan among regions of RF in terms of indices of extents of medical aid.
2. Positioning of Bashkortostan among regions of RF in terms of budget indices and fund rising for healthcare systems.
3. Positioning of Bashkortostan among regions of RF in terms of indices of people satisfaction with the medical care level and quality.
4. The evaluation of correlation between indices of fund rising, extents of medical aid and people satisfaction.

Input data for the analysis were the analytic review of the implementation of Programme on State Guarantees (PSG) to Deliver Free Medical Care to the Citizens of the Russian Federation in 2008, published on the official site of Ministry of Health Care and Social Development of the Russian Federation, and data of the survey «The research of the people opinion about an availability and a quality of the medical care», passed in 2008 by Federal Health Care and Social Development Inspection Service.

2. METHODS AND MATERIALS USED FOR RESEARCH

The mix budget-insurance model, fixed by the law "On health insurance of individuals in the Russian Federation", guarantees free medical care for people within the Programme on State Guarantees (PSG).

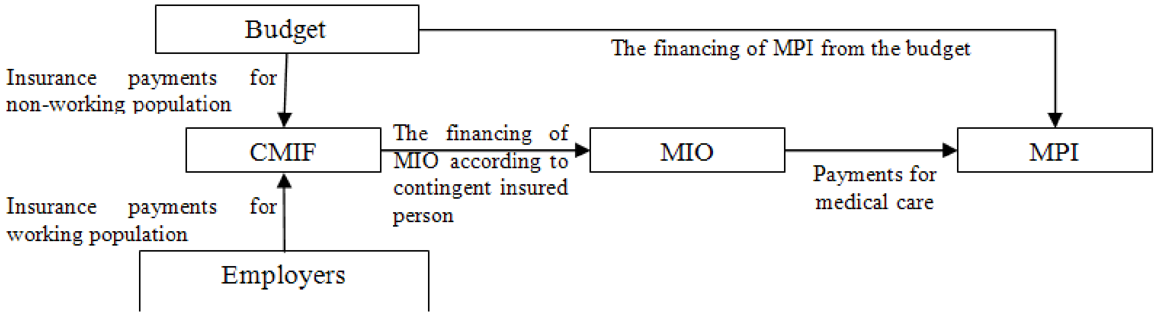

Fig.1. The diagram of financing of MPI (medical preventive institution)

The law proves a financing of free medical care, realized from two major source – funds of compulsory medical insurance fund (CMIF) and all level budgets. The diagram of financing is shown in fig.1.

The CMIF was created for accumulation and proper use of funds for medical care. Funds of CMIF are formed from funds of insurant, volume of payments for every insured person is proportional to salary at the tax rate, fixed by low in RF. The organ of regional government is an insurant for non-working people, volume of payments is defined in the process of budget adoption every year.

Medical insurance organizations (MIO) contract about compulsory health insurance and issue policy to insured people. According to sex-age structure of insured people MIO get funds from CMIF every month. MPI deliver medical care to insured person and draw up an account to MIO, who will pay it later. As a rule, MIO pay only for some expenses, other expenses are financed from a budget.

PSG of RF contains the list of types of medical care, provided free of charge, normatives per capita of financing and volumes of medical care, and sourcesof its finance. PSG of RF is foundation for Territorial Programmes on State Guarantees (TPSG), elaborated and confirmed by every subject of RF every year. Regional organs of government can extend the list of types of free medical care in the process of elaborating of TPSG, and change sources of finance of certain types of medical care and expenses. In some regions regional authorities prefer to finance MPI mainly from a budget, in other regions tend to move to single-channel finance model, when the main volume of expenditures on healthcare goes through CMIF.

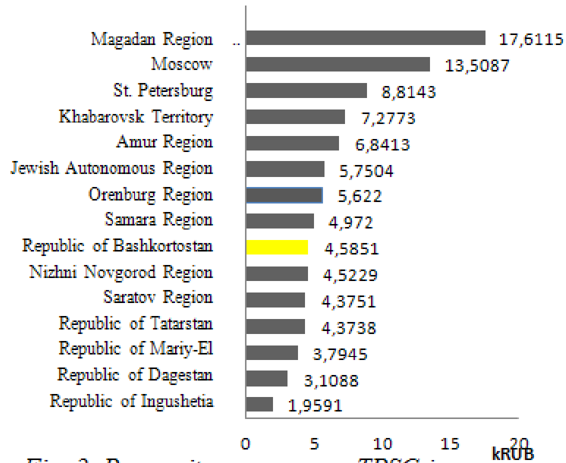

Fig. 2. Per capita expenses on TPSG in regions of RF in 2008

3. Results and achievements

3.1. The analysis of differences in fund rising and levels of financing between regional healthcare systems

Per capita expenses on TPSG in regions of RF are shown in Fig.2. As is shown in Fig. 2, levels of financing are very different in regions.

The part of CMIF`s founds in financing of TPSG is shown in Fig.3.

As is shown in Fig.3, the part of CMIF`s founds in financing of TPSG is also very variable. In the RB the part of CMIF`s founds in financing of TPSG is 53,86%. The correlation between per capita financing and a part of CMIF`s founds in financing of TPSG is weak and negative (r=-0,281 (p=0.01)).

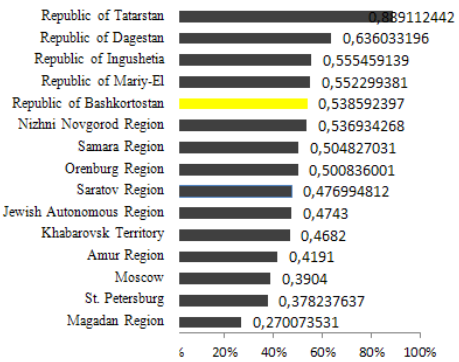

Fig. 3. The part of CMIF`s founds in the financing of TPSG

3.2. The analysis of differences between volumes of medical care

The quantity of ambulance call-out, polyclinic visits, bed-day in hospitals per capita are shown in Fig.4-6.

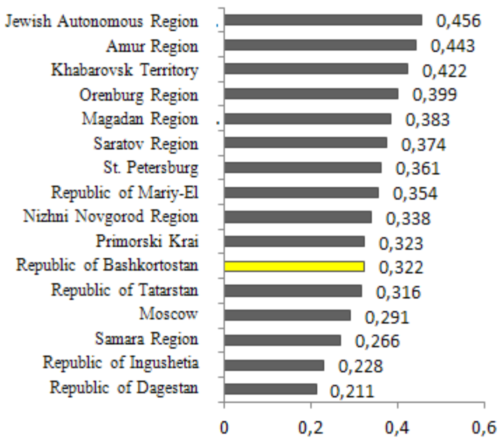

Fig. 4. The quantity of ambulance call-out in 2008

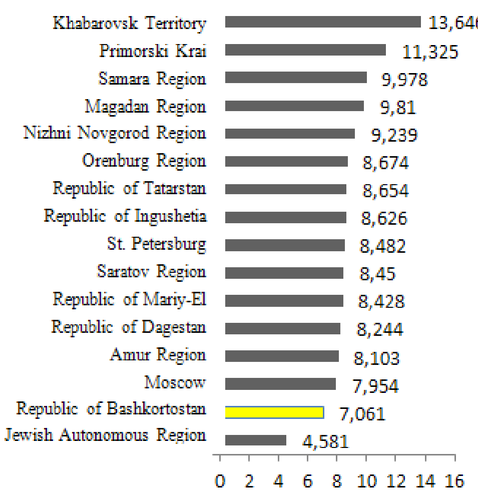

Fig. 5. The quantity of polyclinic visits in 2008

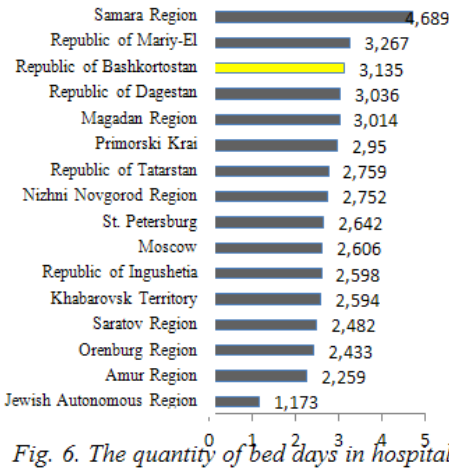

Fig. 6. The quantity of bed days in hospitals per capita in 2008

As is shown in Fig.4-6, volumes of medical care per capita are different in regions.

The arranging of regions was conducted in terms of volumes of medical care (the smallest rank, equal 1, was assigned to region with the biggest indicator value). The diagram, allowed to compare RB with some other regions, is shown in Fig.7.

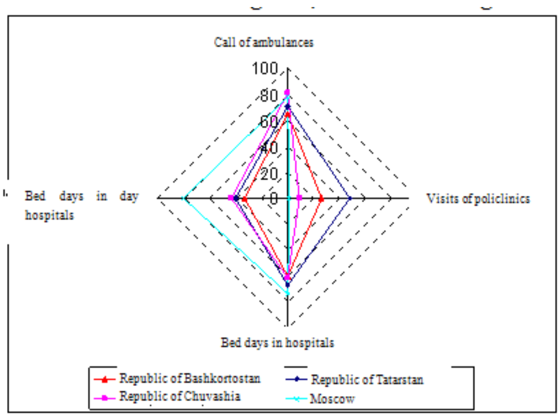

Fig. 7. The positioning of RB in the coordinate space of volumes of medical care

3.3. The analysis of differences in levels of satisfaction from the medical care in regions of the RF

The percentage of respondents, satisfied with medical care respectively in policlinics, hospitals and ambulances is shown in Fig.8-10.

For example, people of the Republic of Dagestan are least of all satisfied with medical care (22,36%), best of all – people of the Republic of North Ossetia (79,88%). In the RB this index is 56,51%.

The diagram, allowed to compare the RB with some other regions, is shown in Fig.11.

3.4. The analysis of correlation between indices of the financing level, extent of medical aid and the level of satisfaction with a medical care

For the analysis of correlation between indices of the financing level and indices of extent of medical aid and indices of satisfaction it is necessary to calculate correlation coefficients between these indices and to estimate their significativity.

The high correlation is observed (r=0,767 (p=0,000), r=0,836 (p=0,000), r=0,866 (p=0,000) between indices of satisfaction with medical care in policlinics, hospitals, and ambulances.

That is to say the people of region, satisfied with some type of medical care, are satisfied with other types, it probably caused by general level of medical care in region

Indices of volumes in terms of every type of medical care correlate weekly among themselves.

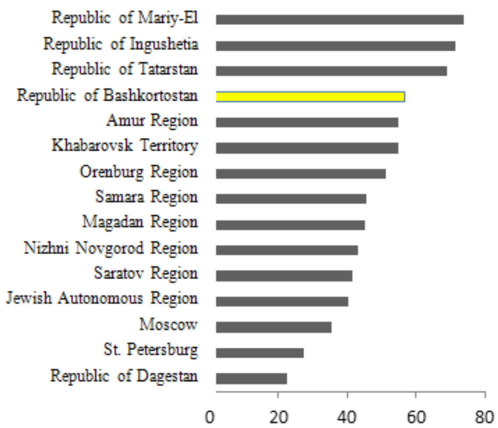

Fig. 8. The level of satisfaction with medical care in policlinics

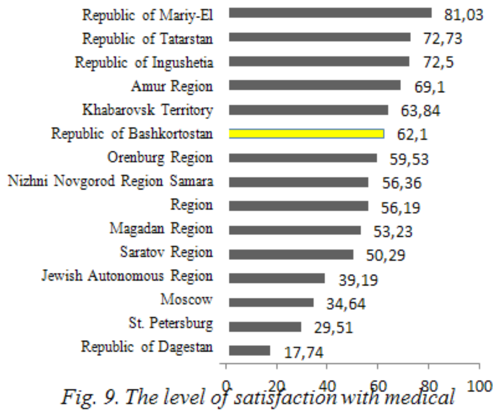

Fig. 9. The level of satisfaction with medical care in hospitals

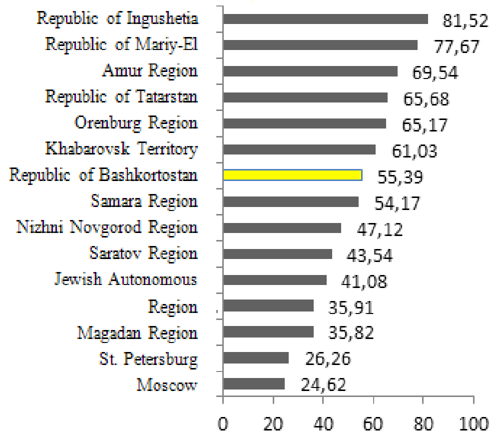

Fig. 10. The level of satisfaction with medical care in ambulances

The high correlation is observed (r=0,834 (p=0,000), r=0,844 (p=0,000), r=0,889 (p=0,000) between indices of financing of policlinics, hospitals and ambulances, it is caused by general level of financing of regional healthcare.

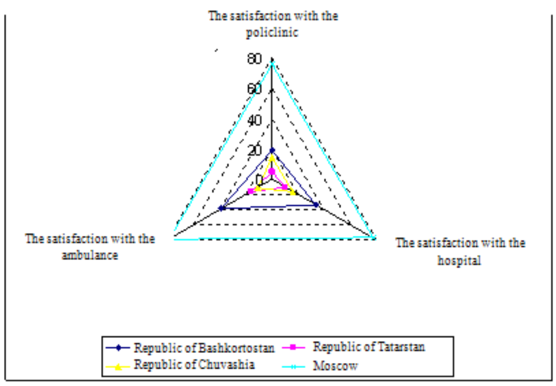

Fig. 11. The positioning of RB in the coordinate space of indices of satisfaction with medical care

Indices of volumes correlate with indices of financing for ambulances and policlinics very weakly (r=0,08 (p=0,483), r=0,018 (p=0,876) соответственно). Only for hospitals it is observed (r=0,4 (p=0,000)) medium correlation: the quantity of bed-days depends on the hospital financing.

In a part of investigation of correlation between the financing and satisfaction, expected direct relationship is absent, moreover correlation coefficients are negative (r=-0,178 (p=0,117) for policlinics, r=-0,197 (p=0,082) for hospitals and r=-0,318 (p=0,004) for ambulances). In such a way, a level of satisfaction is ordered by other factors (availability, a level of management and others).

4. Conclusions

As a result of analysis of differences in organization, levels of financing, volumes and levels of satisfaction with medical care in regions of RF it was discovered the weak negative correlation between the level of per capita financing and the part of CMIF funds in TPSG financing, it is observed the high correlation between indices of financing in terms of all types of medical care, it is also observed the high correlation between indices of satisfaction in terms of all types of medical care, defined by general level of regional healthcare financing.

The investigation of correlation between finance indices and satisfaction terminate in unexpected results: the level of satisfaction do not depends and even is the opposite to level of financing, which invites further investigations of satisfaction components and investigations of an organization of medical care and distribution of flows of funds in sectors of healthcare.

Modified methodical procedure for implementation of ergonomic program

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Abstract

General model ergonomic program was designed so that, it could become part of the company's programs oriented for health and safety at work in specific conditions of companies in Slovakia. Working conditions shall contribute to enhancing the effectiveness of human labour, improving the quality of life of employees and protect their health in terms of long-term sustainability of environmental quality, which to them that allow regeneration of the workforce. On base from the current state of the industrial companies in Slovakia, it is necessary to propose measures might be undertaken introductory activity for start ergonomic program in the company and then could be gradually implemented ergonomic program into company practice. These measures are summarized in the form of modifications to the process of putting an ergonomic program to companies, depending on their specific conditions. This paper focuses on a comparison of general and modified model ergonomic program and description of each step of the modified method of the ergonomic program for implementation into company.

Keywords: Ergonomic program; Method;; Procedure; Employees.

1. INTRODUCTION

Essential part of his life a man survives in work activities. The effect of work to human can not be overlooked, therefore, effort to adjust the means of work to the features of the man emerge from the days, when man began to use simple hand tools.

In the Slovak Republic are very slowly getting the overriding need is a sort of "facilitating the work of" employee health concerns work load, and also attempt to comfort it in the workplace. Even after the great influx of foreign investors, particularly in industry, there is a tendency not to develop but the use of workforce employees. This attitude has not great chance of survival in the future, because this approach is depleting potential sources of employees and current employees will not be able to carry out work on health reasons. For this reason is necessary to introduce ergonomic program in companies, which enables to analyze the current situation in companies, to propose appropriate technical and organizational measures for its improvement and yearly checking the effectiveness of measures taken.

2. METHODS AND MATERIALS USED FOR RESEARCH

The general model of the ergonomic program was designed to become a part of company's health and safety programs in the specific conditions in Slovak companies. However, in the original methodical procedure was implementation of the ergonomic program directly related to the participation of specialists in the field of ergonomics, what was proved as lack in the performance of the analysis in Slovak companies.

2.1. The assessment of original steps of the methodical procedure of the general model ergonomic program

The original methodical procedure (Figure 1) is based on Slovak legislation that is harmonized with EU legislation and it generally requires:

- regular analysis of risks in the workplaces;
- acquaintance employees with these risks;
- realization of preventive measures.

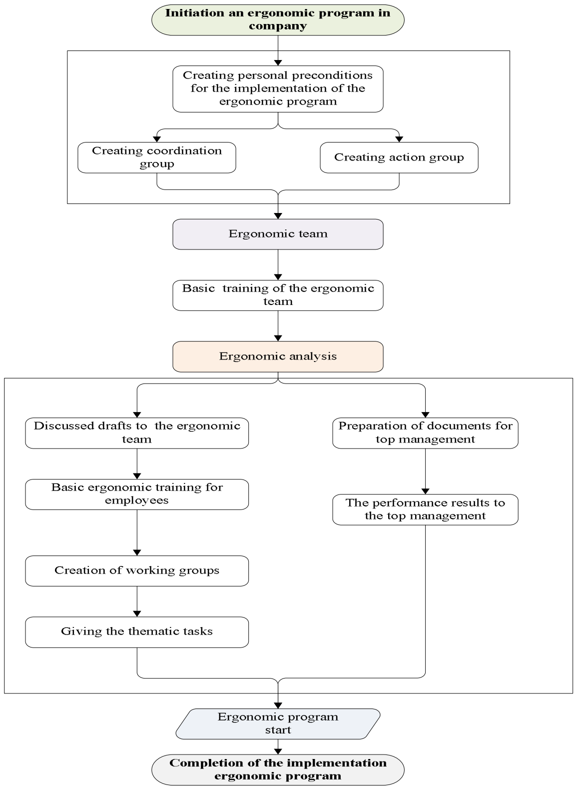

Fig. 1. Graphic representation of the original methodical procedure

The basis for successful management of ergonomic program and coordination all ergonomic activities is according to the original methodical procedure the ergonomic team, splits into a coordinating board and the action group, which meets regularly at least once a year. By processing data from the analysis was revealed that the original methodical procedure can not be applied in full range in the small and medium-sized companies.

2nd phase – *the starting of an ergonomic program* – as the analysis showed, it is necessary to inform employees about planed change in the form of an ergonomic program for their direct participation into the program. Informedness can company to ensure through employee training, information screens or company's magazine. It is necessary to elaborate this phase details, ergonomic program to start was made possible without the direct participation of specialists in the field of ergonomics. Already at this phase it is necessary to make a detailed ergonomic analysis and on the basis of its results to design the order of solution identified problems in terms of their severity, which will be considered at a next phase by determining priorities for further action. As ergonomic team would be crystallize during the solution to an ergonomic program, it will be the better the results of ergonomic analysis and resulting priorities for solution to discuss with the management of the company or financial manager, and then to determine the procedure for undertaking a viable solution. Effort is that the ergonomic program can be implemented in a difficult financial situation, that the efforts to implement it didn't crash to lack of funds and jeopardize the existence of the company. At this phase it is necessary to carry out basic training for employees about the results of ergonomic analysis.

3rd phase – *implementation of the ergonomic program* – at this phase would be more appropriate to focus on the creation of an ergonomic team. Number of members of the ergonomic team may not be the final, it may be amended and changed by the nature of the problems solved. In the thematic tasks for employees is necessary to determine the rules as they will be implement and evaluate the tasks that didn't ensure counterproductive or even didn't motivate unsuccessful solvers. At present, employees have not sufficient confidence in the ergonomic program, so the thematic tasks they will be willing to perform once they adopt an ergonomic program. In this phase it is necessary to elaborate also in addition to health impact assessment, in the economic benefits of ergonomic program too. Both components of the evaluation will be possible to well-evaluated after at least yearly the functioning of the ergonomic program in the company. Designed ergonomic team already then will be able to coordinate the next action in forward in addressing ergonomic program so as to achieve its full integration into the company.

Based on the findings from the analysis of the current situation in industrial companies in Slovakia, it were be proposed measures as might be made an initial start-up activities for starting ergonomic program in the companies and then it could be gradually implemented in company practice. These measures are summarized in the form of modification of the procedure of putting the ergonomic program to companies depending on their specific conditions.

So as facilitate the implementation of an ergonomic program in companies, it was added particular parts to the current methodical procedure by of the priorities identified by the results of the analysis. This resulted in a modification, which enabled its implementation, even without direct participation of specialists in the field of ergonomics.

Using this methodical procedure, companies will be able to initiate an ergonomic program in their operations, and also be able to continue in an ergonomic program without the direct participation of specialists in the field of ergonomics.

3. MODIFIED METHODICAL PROCEDURE FOR THE IMPLEMENTATION OF ERGONOMIC PROGRAM

The practice shows that it is necessary to address the care of employees because they have potential for increasing economic company success. As the experiences abroad show, full health care and welfare of employees can provide an appropriate ergonomic program, which is "tailored" for a particular company. In Slovakia operates many companies with foreign owners, who bring need to care for employees from the home environment. For the Slovak market was made a methodical procedure based on the general model of ergonomic program. However, as was shown in the analysis, an implementation of an ergonomic program in the present form requires direct participation of specialist in the area of ergonomics, who the companies do not, so is necessary to adjust present methodical procedure, as so the company would to implement an ergonomic program into their practice gradually, without direct participation of specialist in the field of ergonomics. Modified methodical procedure (Figure 2) assumes that in the company is not a specialist in the field of ergonomics and the company decides to implement an ergonomic program with using trained employees, who are already working in the company.

The level of implementation, which the company chooses, depends on the amount of funds that can be released to implement correctional measures necessary to start up an ergonomic program. Modified methodical procedure:

1. *Incurrence the interest for the initiation of the ergonomic program;*
2. *Ergonomic analysis;*
3. *Presentation the results of the ergonomic analysis to the top management;*
4. *Top management decision about implementation of the ergonomic program;*
5. *Implementation of the ergonomic program:*
    a) <u>Supply concept of implementation ergonomic program;</u>
    b) <u>Internal concept of implementation ergonomic program:</u>
        – Innovatory movement;
        – Implementation of organizational measures;

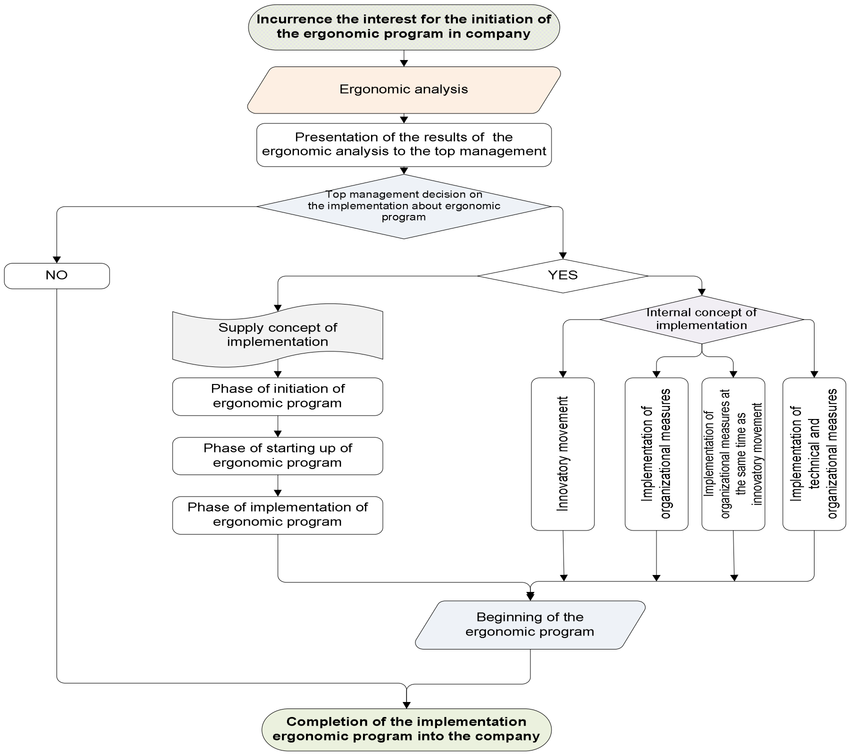

Fig. 2. Graphic representation of the modified methodical procedure

- Implementation of organizational measures at the same time as innovatory movement;
- Implementation of technical and organizational measures.

4. CONCLUSION

Ergonomics, applied through the implementation of ergonomic programs, is a new element in the management of companies in Slovakia. This issue increases importance, in conditions of Slovak companies too, the retirement with age of employees and with the need for increasing effectiveness manufacturing of companies.

Only few companies in the Slovak Republic are aware of the importance and potential implementation of ergonomic programs in company practice. However if they are interested in implementation an ergonomic program, these efforts aborted account on excessive demands on the implementation of the methodical procedure the general form of an ergonomic program, which was available yet.

For successful implementation of the ergonomic program into the daily life of the company is important to ensure:

- theoretical training and development of the employees;
- ergonomic conditions for the functioning of the program;
- elimination of the negative impact of factors operating in the working environment for employees.

5. ACKNOWLEDGEMENTS

This paper is one of the outcomes of the dissertation thesis.

MARKOVÁ, P.: The proposal of measures for implementation ergonomic program into middle-size companies: Dissertation thesis. - Trnava: STU in Bratislava MTF, 2010. - 155 p.+app. - MTF-10904-27920.

Responsibility for employees: occupational health and safety

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Abstract

Human potential have limitless creative and developmental possibilities. Human capital creates new value and shaping a new reality and it's the biggest source of competitive advantages. Yet sometimes they do not care enough about safety of human capital. This paper discusses the role of manager's responsibility for the health and safety of human capital through the acceptance and implementation of standard safety and security of employees, the manner of implementing these measures and monitoring results. In the practice is still occurring cases of injuries of employees, and is increasingly being spoken about the problem of absence from work and what its cost about. According to the data for Republic of Croatia (2009-2010), there are still opportunities to reduce costs of occupational injuries. Focus on occupational safety and health will result in reducing the number of days of absence. In addition to safety and security, increasingly important is becoming a long-term mental health of employees. A new challenge for managers is to form a strategy for preserving and improving mental and physical health and safety of employees. It means using human capital in a sustainable manner. According to World Health Organization, until 2020. years, depression will be second disease in human population, all ages, both sexes. This could be a warning signal for companies and managers who should devise a new approach to employees, to go one step further. There is a need to create an organizational behavior that has a positive influence on all aspects of safety and health of employees. This paper discusses the factors on overall health benefits and safety of employees, holders of the activities and ways of monitoring performance.

Keywords: Costs; Occupational health; Safety; Employees; Absenteeism; Job satisfaction; Organizational behavior.

1. INTRODUCTION

Human capital creates new value and should continuously improve trough education and professional development. Investment in knowledge is a long term process. It is therefore necessary to retain quality employees, create an organizational behaviour that fosters good relations between employees.

This paper examines the framework of organizational behavior toward employees: legislation, data on the number of injuries to the National Classification of Activities for the period 2009 to 2010 for the Croatian area, future forecasts of the World Health Organization in the field of mental health and their possible impact on the health of working population. The aim of this study was to determine whether the law protects employees' overall health: physical, mental and spiritual health and how to monitor the results at the national level.

2. METHODS AND MATERIALS USED FOR RESEARCH

In this paper used data on the injuries of the Croatian Institute for Health Protection at Work for the period between 2009 and 2010, the Law on Protection at Work, Law on Amendments to the Law on Protection at Work. Also are used data of the study My job site-related to office rage, the stress at work on a sample of 1000 respondents. The following table shows the injuries in 2009 – 2010 according to National Classification of Activities.

According to the Croatian Institute for Health Protection at Work, there is a high proportion of injuries in industry: [1]

- Manufacturing
- Construction
- Wholesale and retail trade, repair of motor vehicles.

Table 1. Injuries by activity, 2010. (%) [1]

Agriculture, forestry and fisheries	3,51
Mining and quarrying	0,44
Manufacturing	28,64
Electricity, gas, steam and air conditioning	1,51
Water supply, sewerage, waste management and remediation activities	2,65
Construction	9,82
Wholesale and retail trade, repair of motor vehicles and motorcycles	10,60
Transportation and warehousing	6,82
Activities to provide accommodation and food services	4,53
Information and communication	1,21
Financial and insurance activities	1,74
Real estate	0,32
Professional, scientific and technical activities	2,08
Administrative and support services	2,22
Public administration and defense, compulsory social security	7,31
Education	4,92
Human health and welfare	8,78
Arts, entertainment and recreation	1,52
Other services	1,30
Unknown	0,10
Total	100,00

These activities are labelled as risky activities for employees. In 2009 year it's observed the same result. Activities with high risk for injuries in 2009 are: [2]

- Manufacturing (31,27 %)
- Construction (12,50 %)
- Wholesale and retail trade, repair of motor vehicles

Table 2. Injuries by activity, 2009. (%) [2]

Agriculture, hunting and forestry	3,33
Fishing	0,10
Mining and quarrying	0,57
Manufacturing	31,27
Electricity, gas and water	3,42
Construction	12,50
Wholesale and retail trade, repair of motor vehicles	12,11
Hotels and restaurants	3,71
Transport, storage and communication	6,82
Financial operations	1,43
Real estate, renting and business services	2,41
Public administration and defense, oby. Social Insurance	7,11
Education	3,53
Health and social care	7,57
Other community, social and personal service activities	4,10
Private households with employed persons	0,00
Extra-territorial organizations and bodies	0,01
Total	100,00

64, 7 % of injured workers are male and 35,71 % are women [1]. The most commonly injured workers are employees with lower qualifications.

94,60 % of employees are trained and educated to work safely, only 2,30 % was not trained.

Similar informations are repeated in 2009 year.[2]

2.1. Overall health and safety of employees

The Law on Protection at Work provides respect for human dignity.[3] In accordance to modern concepts, a human being has vegetative soul, psychic soul and spiritual soul [4]. Psychological and spiritual levels are responsible for imagination and creativity.

It is not enough taking care of just to the physical security of the workplace. According to a study of My Job web portal about stress at workplace, it was concluded the following about the consequences of stress: [5]

- 57 % of respondents had problems with sleeping,
- 32 % of respondents in the last year at least once absent from work,
- 26 % of respondents changed their job (men 24 %, women 28 %),
- 15 % of respondents had an increased consumption of alcohol,
- 19 % of respondents started smoking
- 43 % of respondents had an increased consumption of sweets and snacks.

Each of the mentioned consequence of stress has its own effect on staff costs:

- absence from work causes the loss of working hours and reduced work productivity (costs for company) [6]
- hiring new employees increases costs for the company (training of new people, introduction into practice), costs for company,[7]
- Consumption of alcohol, smoking, increased consumption of sweets and snacks (expected future cost for public or private health insurance companies).

Stress is the result of work overload. Long term consequences of stress may be a psychosomatic or psychological illness. Reasons for work overload can be:[8]

a) a large volume of work per employee, which must be done,

b) Inadequate qualifications for the job, insufficient communication or social skills.

Solving mentioned reasons are in the management of human resources.

2.2. Human Resource Management

Human Resource Management is responsible for activities of monitoring, evaluation and promotion of employees. In this regard, the department of Human Resources should bear the responsibility for monitoring of work processes, work productivity, work quality, organizational behavior.

Stress at work is not desirable situation for employees. Department of Human Resources Management measures staff turnover, satisfaction at work, absence form work, job performance. Also, manes conflicts, advises top management. This department is crucial department for all technical matters related to employees. He has an impact on all departments and at all levels of management.

3. RESULTS AND ACHIEVEMENTS

Research shows that 78 % of respondents in the workplace are under the daily stress. [5] In accordance with prognoses by the World Health Organization on the condition of the population and mental health by 2020. year, it is considered that the depression will be the second most frequent illness.[9] It is a serious signal for management of human resources which should be extended to the leadership of human resources.

In this regard should develop strategies to design a workspace that enables:

1. Improve employee qualifications and training of the necessary skills for a particular job,
2. Make an assessment of stress level for a particular job,
3. To train communication and social skills of employees,
4. Educate employees about stress and stress management,
5. Monitored regularly the absence from work, to measure and eliminate organizational reasons,
6. Improve cooperation and support between departments,
7. Regularly analyze job satisfaction,
8. Optimally allocate work,
9. Analyze overtime work and analyze the reasons for overtime with manager.

4. CONCLUSIONS

The Law on Protection at Work, Law on Amendments to the Law on Protection at Work stipulate protection at work, the bearers of activities and subjects of activity. Despite the regulations, supervision of the State Inspectorate and the strict punishment, employee injuries are happening. According to reports from the

Croatian Institute for Health and Protection at Work in two observed year have been registered a high percentage of repeated injuries in Manufacturing, Construction and Wholesale and retail trade, repair of motor vehicles. Injury at work caused the cost for public health system. It is required stricter oversight of these activities and higher penalties for failure to use safety.

Stress at work causes long – term effects on health, causing absence from work, increased costs of lost working hours. Philosophy of Human Resources Management shall develop and apply new methods of managing human resources that identify a stressful environment and manage stress. A report of the Croatian Institute for Health and Protection at Work does not contain information about diseases caused by stress, although the majority of survey respondents considered that it was under negative influence of stress.

Diseases caused by stress in the workplace should be monitored as an injury caused by stress at workplace.

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The Role of the State in the Economic Growth of the Cultural Sector in the EU

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Abstract

The democratization of culture forced changes in the role of the state in subsidizing culture. The role of the state is still determining in the economic performance of the cultural sector of the EU Member States, but there are differences in the methods and in which subsector of the cultural sector has to be reformed. In this article we are comparing the coordinated and liberal cultural financing aspects to demonstrate how these two contradictory theories try to accustom their best-practice to the institutional system, which has been changed by the democratization of culture since the 1960s. This new situation raises questions such as which aspect is more successful in accustoming to the modified institutional system, what kind of reforms have been made in the two aspects to keep the sustainability of the cultural sector. To show the tendencies the cultural sector and financing system of the EU Member States are analysed.

Keywords: Cultural Economics; The European Union; The Role of the State; Cultural Financing; Cultural Management.

1. INTRODUCTION

The puzzle of the article is why some Member States are not able to produce the same economic efficiency in their cultural sector even if they use very similar cultural financing models, while other Member States perform almost the same high level of economic efficiency with using totally different models. The assumption is that the form and the quality of the State intervention are much more relevant than the size of the State intervention and financial support in the economic development of the cultural sector.

2. METHODS USED FOR RESEARCH

The cultural sector being analysed refers to the concentric circles model of the cultural industry [1].

1. Core creative arts: Literature; Music; Performing arts; Visual arts.
2. Other core cultural industries: Film; Museums and Libraries.
3. Wider cultural industries: Heritage Services; Publishing; Sound Recording; Television and Radio; Video and Computer Games
4. Related industries: Advertising; Architecture; Design; Fashion

To group the EU Member States we analyse the cultural policy strategies focusing on the following criteria:

1. The existence of independent arts councils,
2. The role of the private sector in the financing of culture,
3. The existence of competition for government subsidies,
4. The development and the efficiency of the taxation system on culture,
5. The development and the role of the non-profit sector.

To name the two main cultural financing aspects we borrow the terminologies from comparative political economy [2]. In the model the countries are belonging either to the coordinated cultural financing model or to the liberal cultural financing model.

Austria, Belgium, Czech Republic, France, Poland, Hungary, Germany, Italy, Portugal, Spain, Slovakia and Slovenia use the coordinated cultural financing model.

Denmark, Finland, the Netherlands, Ireland, Sweden and the United Kingdom prefer the liberal cultural financing model.

It is important to admit that there is no strong connection between the coordinated and liberal capitalist systems and the coordinated and liberal cultural financing models, as it is demonstrated in the grouping that not all the countries use the same system in their general economic and cultural financing system (*Scandinavian countries, the Netherlands*).

In the research the focus is on the comparative analysis of the EU Member States' cultural sectors, therefore the methodology of comparative economics is applied.

3. RESULTS AND ACHIEVEMENTS

The variables used in the comparative analysis

1. GDP per capita (USD)
2. Intellectual Property Rights Index
3. Culture Index
4. Human Development Index
5. Human Capital Index
6. Cultural Sector Employment
7. Household Expenditure on Culture
8. Direct Government Support for Culture in % of GDP
9. Cultural Sector Value added to GDP

The data of *Table 1* demonstrate that the value added to GDP of the cultural sector is higher in those Member States, which use the liberal cultural financing approach in their cultural policy. The only exception is Ireland in which country the liberal approach is combined with fiscal centralisation, so a kind of hybrid model is used. The highest level of value added to GDP is generated in France, which country uses the coordinated cultural financing approach in the most homogenous and efficient way. All the other Member States using the coordinated model have lower level of growth in the cultural sector. The lowest results are produced by Hungary and Poland.

The Human Capital Index is much higher in the liberal countries than in the coordinated ones. The main strategy of the liberal countries is to increase the level of human capital as the more educated the people are, the more cultural goods and services are consumed.

The household expenditure on culture shows the same tendency as the value added to GDP of the cultural sector. The households spend higher amount form their budget on cultural goods and services in the liberal Member States. Ireland's result is behind the other members of this group. Although Ireland uses almost the same strategy in its cultural financing as the United Kingdom, in the latter the families consume more cultural goods and services. The coordinated countries' results are reaching only the average of the liberal ones, the only positive exception is Austria. It is also showed from the database that the household expenditure on culture is the lowest in the Mediterranean and the post-socialist countries.

When analysing the direct government expenditure on culture in % of GDP it is shown that in both groups there are countries, which support culture with higher amount from the GDP, while others reach almost the same economic growth in the cultural sector with lower government subsidy. The average of direct government expenditure is almost the same of the two groups, so it raises the question whether the size of government support for culture can increase the growth of the sector. If the answer is no; then which factors have influence on the economic performance of the cultural sector?

The data also demonstrate that the Scandinavian countries use higher direct government support than the Anglo-Saxon ones, but the resource allocation is very similar as it is based on the arm length aspect. If we compare the coordinated countries, it is very clear that if two countries use the same cultural financing model it does not mean that they reach the same efficiency. The best example for this phenomenon is the case of France and Hungary, the former has the highest level of value added to GDP, while the latter has the lowest one with using a quite similar strategy.

The data on HDI index show very slight differences. The results are higher in the liberal countries. Hungary, Poland, Slovakia and Portugal have the lowest level of HDI, which results are under the average of the coordinated group and far behind the results of the liberal financing model using countries.

The GDP per capita as a general economic variable is also implemented into the analysis as we would like to prove the assumption that it is not automatic that the more developed a country is, the more direct government subsidy is spent on culture. Ireland has one of the highest levels of GDP per capita, but the government expenditure on culture is 0.5 % of the GDP. The Hungarian case is the opposite. Hungary has one of the lowest levels of GDP per capita, but the size of direct government expenditure in % of GDP is 1.6%.

The Culture Index is implemented into the analysis to test the role of informal institutions on the economic performance of the cultural sector. The highest level of culture index exists in the Scandinavian countries. All the other liberal cultural financing countries have lower level of informal institutions. Among the coordinated countries Austria, Germany and France have the highest level of culture index, but these results are only reach the average of the liberal ones.

The intellectual property rights index is a very important variable as it demonstrates the quality and the enforcement of the State rules and laws. The data show that those countries have the highest GDP growth in the cultural sector, where the intellectual property is highly saved and enforced. So beside the level of human capital, this variable has also important role in the economic performance of the cultural sector.

The level of employment of the cultural sector is the highest among the liberal cultural financing countries, which is combined with the entrepreneurial employment approach.

As a summary of the comparative analyses it can be stated that the coordinated and liberal cultural approach using countries use different priorities to increase the economic performance of the cultural sector. The most robust result is that the size of direct government support has little or no influence on the value added to GDP of the cultural sector.

4. CONCLUSIONS

The article's main aim was to prove that the Member States in the European Union use many different cultural policies and financing strategies to improve their cultural sector efficiency. The author assumes that the role of human capital and the level of intellectual property in cultural consumption and the increase of cultural sector efficiency is determining. To prove the hypothesis the different types of cultural financing models were compared and tested.

Thesis: The new approach, called the democratisation of culture, made changes in the role of the State. The role of the State is determining in the financing of the cultural sector of the Member States, the main differences are in the target of the cultural policy and the strategy used to increase economic growth of the cultural sector. We argue that the quality and the form of State intervention is more determining than the size of State support.

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Table 1. The Main Statistical Data of the EU Member States' Cultural Sectors

Country	IPR index	Culture index	Cultural Sector Employment (%)[c]	Cultural Sector Value added to GDP (%)[c]	Household Expenditure on Culture (%)[d]	HDI index	GDP per Capita (USD)[e]	HCI index	Direct Government Expenditure on Culture in % of GDP[d]
Liberal Cultural Financing Model									
Denmark	8,10	9,19	3,30	3,10	5,30	0,86	35217	14,00	1,60
Finland	8,50	7,91	3,70	3,10	5,70	0,86	32736	29,00	1,20
The Netherlands	8,00	9,24	4,20	2,70	4,80	0,88	36548	21,00	1,40
Ireland	7,60	4,74	3,40	1,70	3,10	0,89	40716	30,00	0,50
The United Kingdom	8,20	3,47	3,80	3,00	7,70	0,84	32990	19,00	0,90
Sweden	7,60	10,0	3,60	2,40	5,30	0,88	34870	8,00	1,10
Average	**8,00**	**7,425**	**3,67**	**2,67**	**5,32**	**0,87**	**35513**	**20.1**	**1,12**
Coordinated Cultural Financing Model									
Austria	7,90	6,64	3.00	1,80	6,60	0,84	35695	23,00	0,90
Belgium	7,90	3,41	2,70	2,60	4,70	0,86	33527	31,00	1,30
Czech Republic	5,80	5,00	2,50	2,30	5,90	0,84	22009	26,00	1,20
France	8,10	5,32	2,50	3,40	5,20	0,86	31048	30,00	1,50
Hungary	6,20	4,09	2,60	1,20	4,30	0,80	18154	30,00	1,60
Germany	8,40	5,86	3,20	2,50	5,20	0,88	31950	36,00	0,60
Poland	5,70	4,26	1,90	1,20	4,00	0,78	14541	34,00	1,00
Italy	6,50	4,80	2,80	2,30	4,10	0,84	28866	48,00	0,80
Portugal	7,10	3,01	2,30	1,40	4,20	0,78	20839	37,00	1,00
Spain	6,40	3,73	3,10	2,30	3,30	0,85	29382	38,00	1,40
Slovakia	6,30	3,72	1,90	2,00	5,00	0,80	17585	32,00	1,20
Slovenia	5,50	4,19	3,60	2,20	5,50	0,81	24837	22,00	1,10
Average	**6,81**	**4,025**	**2,675**	**2,4**	**4,83**	**0,83**	**25703**	**32,20**	**1,13**

Sources: a www.internationalpropertyrightsindex.org; b Williamson – Kerekes (2008); c KEA (2007); d OECD (2009); e OECD (2008);f Ederer (2008) and Ederer–Schuler–Williams (2008); g http://hdr.undp.org/en/statistics/ (UNDP, 2007)

Slovak Innovation Policy: Current Status and Main Challenges

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Abstract

Slovak Republic is considered to small and extremely open economy. Therefore, Slovak companies are exposed to rising global competition. According to international indicators, Slovak innovation environment is weak and insufficient for market position maintaining, especially in SMEs. Slovak government is aware of this situation and as answer to these challenges adopted strategic material Innovation Strategy of the Slovak Republic for 2007 to 2013. Consequently two generations of Innovation Policy of the Slovak Republic were adopted. The main objective of both Innovation Policies is to develop individual measures of the Innovation Strategy of the Slovak Republic for 2007 to 2013 into specific measures and tasks. Present paper will analyze implemented measures of the first generation Innovation Policy as well as evaluate jumping-off place of the second generation Innovation Policy. Attention will also be focused on comparison of both Innovation Policy generations. Additionally main barriers and obstacles of implementation will be evaluated in more details. Also, new opportunities in financial entrepreneurship via Innovation Policies measures will be introduced with focus on overall allocation. Paper will also be centered on main weaknesses and selected challenges to which Slovak Innovation Policy and real economy are currently facing. Finally, selected recommendation for future Slovak Innovation Policies will be discussed in details.

Keywords: New Opportunities in Financial Entrepreneurship; Innovation; Policy; FDI, Infrastructure.

1. INTRODUCTION

Innovations are getting main driving force of economic activities all over the world [1]. Therefore many countries have active tools for economy fostering via various approaches stimulated innovations [2]. Summary Innovation Index describing innovation activities during the 2010 developed counties as Finland (0,696), Sweden (0,750), Germany (0,696), UK (0,618), US (0,672) are much higher that of Slovak Republic (0,269) [3]. It could be concluded that this high difference between these counties exist for long period of time. Innovation Policies are become integral part of government portfolios of many developed countries. Countries like Finland, Sweden, Germany, UK, US with active innovation policies are considered to leaders in innovation activities. As a consequence their international innovation-related rankings are high. Slovak government is aware of these challenges, and therefore Slovakia's innovation strategy and two generation of Innovation Policies were adopted by the Government of the Slovak Republic.

2. SLOVAK APPROACH

2.1. Slovak Innovation Strategy

Slovakia's innovation strategy until 2013 was adopted on 2007. Its strategic objective was declared as innovations will become one of the main tools of knowledge economy development and ensuring high economic growth of the Slovak Republic with the objective of achieving the level of the most advanced economies of the European Union [4]. Main priorities of the Innovation Strategy are as following: High-quality infrastructure and an efficient system for innovation development (1), High-quality human resources (2), Efficient tools for innovation (3). In order to fix problems of the Slovak economy, these priorities were mirrored to two generations of Innovation Policies.

2.2. First generation Innovation policy

Innovation Policy of the Slovak Republic for 2008 to 2010 was adopted by Slovak Government at 2007 [5]. Main objective was to develop individual measures of the Innovation Strategy into specific measures and tasks. The main goal of the innovation policy is to create support mechanisms for the formation and development of regional innovation structures, innovation enterprises, partnership and cooperation of companies and universities in the field of research and development, gaining new markets in a sustainable environment so as to ensure and improve the population's quality of life and to draw as much benefits as possible from the prosperity of businesses for the national economy. Based on priorities defined in Innovation Strategy following 13 measures were suggested as suitable way to knowledge based economy: Building regional innovation centers (1), Innovation and technology transfers (2), Support of innovation activities in enterprises (3), Project to establish national information infrastructure and its nationwide use by businesses (4), Operational Programme INTERREG IVC (5), Financial engineering tools (6), Competition "Innovative Deed of the Year" (7), Adapting higher and secondary technical education to the requirements of the practice (8), Lifelong learning system (9), Innovation vouchers (10), Innovation incentives (11), Protection of intellectual property (12), Support to projects seeking funds from the Competitiveness and Innovation Framework Programme (13). Detailed measures description is presented in the Table 1. Overall allocation for the fist six measures was EUR 335 millions. Others were adopted without any financial coverage. Almost half of the overall real allocation was assigned to measures Innovation and technology transfers as well as Support of innovation activities in enterprises. These measures were highly interesting for innovative firms to get external financial support. On the other hand, it could be concluded that only a few measures were fully implemented. Specifically measures with allocated budget, except of first one, were realized. Others were not activated due to different reasons. Mainly different priorities were adopted at different ministries, lack of finance, ministerial sectorialism, and reluctance of political elites to long term planning. Nevertheless, as response to remaining innovation-related demand, second generation innovation policy of the Slovak Republic was adopted by Slovak government.

2.3. Second generation Innovation policy

Innovation Policy for 2011 – 2013 in the authority of the Ministry of Economy of the Slovak Republic was adopted by Slovak government recently [6]. It consists from the same number of measures as 1st generation policy, although they are slightly modified and substituted by newly designed measures. Policy measures are as following: Support to innovative industrial cluster organisations (1), Promotion of innovation and building of innovation awareness across the society (2), Competition "Innovative Action of the Year" (3), Strategic Innovation Material for the Next Planning Period (4), Support to projects applying for funding from Community Programmes to support innovation (5), Innovation education for small and medium-sized enterprises (6), Lifelong learning and counselling system (7), Secondary vocational education (8), National incentive project to enhance Slovakia's innovation (9), Operational Programme Competitiveness and Economic Growth, - Support of innovation activities in enterprises (10),

Financial engineering instruments - innovation funding support and support to increase public spending on innovation (11), Innovation vouchers (12), and Intellectual property protection (13). Newly designed measures are presented in the Table 2 with short description. It is evident that majority of former measures remain the same also in the second generation of the innovation policy. This policy also struggling with same problem – inadequate allocation since only a few measures were adopted with budget for implementation. Specifically, National incentive project to enhance Slovakia's innovation, Support of innovation activities in enterprises and Financial engineering instruments have budget covered by Structural Funds. Especially last mentioned measure create potential for firms growing by JEREMIE initiative setting. This policy could be evaluated as pragmatic rather than insufficiently ambitious. Experts designing second generation hope that this version could be more attractive for policy makers and thereafter feasible.

Table 1. First generation Innovation Policy.

Measure	Description
1.	Regional Innovation Centers should be created in all Slovak self-governing regions.
2.	Promoted technology transfer was linked to innovation transfer in manufacturing technologies and also in services.
3.	Innovation activities and the applied research were supported in businesses by implementation of this measure.
4.	Improve the quality of information system suitable for SMEs was the main purpose of this measure.
5.	Measure was targeted to extension of applicant's number within INTERREG IVC calls.
6.	Measure aim was mobilizing financial for innovation via financial engineering instruments.
7.	Establish of respectable competition of innovative firms was the measure aim.
8.	Main purpose of this measure was defined as adaptation of the secondary technical education system to the requirements of the practice needs.
9.	Needs of the citizens, employers, public administration and educational institutions in adapting to the changing needs in the labour market was the main measure focus.
10.	This measure should ensure the better links between firms and R&D organizations viac newly created supporting mechanism - "non-cash vouchers".
11.	The main goal of this measure was to create incentives to the private sector to increase spending in applied research and innovation.
12.	Intellectual property protection system should be strengthen by implementation of this measure.
13.	Measure was targeted to extension of applicant's number within Competitiveness and Innovation Framework Programme.

2.4. Main Challenges

Currently, there are visible gap between the current approach and the expectation of real economy. It could be highlighted high interest of real economy on pro-innovation infrastructure such as technology/science parks which should be build up as soon as possible. This interest is correlated with proposed regional innovation centers designed by self-governing regions based on precise analysis of regional firm's expectations. Particularly, possible lack of implementation could be considered as high challenge for second generation of innovation policy in the Slovakia. It could be take into consideration that after its successful implementation, policy for the next planning period could be correctly designed, that have to account of all strengthens, and also weaknesses of the implemented actions. Additionally further innovation policy should also be oriented on established foreign firms in the Slovak Republic as well as new potential investors, because they can play key role as a strategic partners in the innovation system. They should become integral part of the Slovak innovation system, because FDI belongs to the group of very important aspects of creating real and functional innovation systems in the developed countries. State strategy for attracting FDI with high added value could likely motivate domestic firms innovates more intensively since rising competition.

Table 2. New measures of the Second generation Innovation Policy.

Measure	Description
1.	Selected activities of industrial clusters will be supported.
2.	Measure concerns to enhancement of image in the innovation area and to draft a comprehensive nation-wide promotion and communication model.
4.	New country institutional arrangement of the innovation system will be defined.
5.	The measure is designed to encourage businesses to increase their participation in Community Programmes.
6.	This measure will provide education and training to firms and entrepreneurs in the field of innovation activities.
9.	Measure will increase motivation of all relevant stakeholders.

3. CONCLUSIONS

State innovation policy actions are considerably getting important economy stimulus. Also, Slovakia adopted two generation of Innovation Policy. Base on detailed study, lack of implementation was observed. Consequently main challenges for innovation policy in place, and also to next planning period were proposed. Mainly infrastructure and FDI with high added value are seen as potentially important driver of the innovations in the Slovak economy.

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Gender Diversity in Research System in the Slovak Republic

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Abstract

The issue of the participation of women in science and research has been solved and discussed in several studies, probably the most noticeably in ´She figures 2009´. However, the topic of gender diversity has been dealt in 7th Framework Programme "Improving gender diversity management in material research institutions" with participation of the Faculty of Materials Science and Technology, the Slovak University of Technology. Not only the topic of participation of women in science and research, but also the issue of women in managerial positions is worthy of being observed a continuously long period continuity. The article deals with the role of women in science and research in Slovakia. The authors try to highlight the Slovak research system with its typical features. However, there is also reflected this phenomenon in neighbour countries. The comparisons are done on female participation in research in EU 27. In the end are summarised the key factors hindering equality in research decision making.

Keywords: Science; Research; Women; Stereotypes; Top management.

1. RESEARCH SYSTEM IN THE SLOVAK REPUBLIC

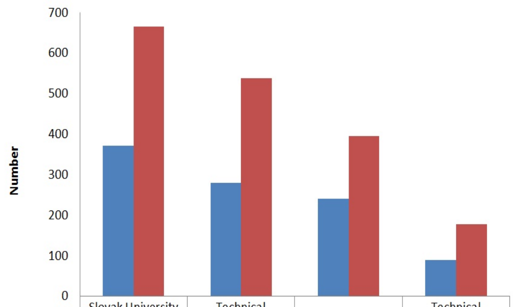
The Slovak research system is divided into four categories: the universities, the Slovak Academy of Sciences, governmental research institutes and private research institutes. Distribution of most financial resources for public, mainly basic research is in hands of the Ministry of Education, Science, Research and Sport of the Slovak Republic and is done on a competitive basis through three funding bodies: VEGA (grant agency for science), KEGA (Grant agency for culture and education) and the Slovak Research and Development Agency. Peer review is the main mechanism in selecting projects for funding. Selection has clear rules and is transparent. According to *Mapping the Maze: Getting More Women to the Top in Research* [1] a gender perspective is missing in the whole process. Slovakia has adopted several laws that should guarantee the equal opportunities for men and women (particularly the *Labour Code and the Anti-Discriminatory Law*). However, their enforcement is still inefficient and formal. Among about 70 women's organisations there are none devoted to the problem of women in research decision making. It has been addressed only vaguely by several individual women scientists who have been involved in EU activities (either Helsinki Group, ENWISE or some other EU FP projects). Institutional strategies, policies and regulations do not address the issue of gender equality in research.

To summarise: "lack of awareness, underestimation or even total denial of the importance of the equality agenda in the research and funding system is the main problem that has a major impact on the under-representation of women in decision-making [1]."

According to She Figures 2009 [2] Women's academic career remains markedly characterised by strong vertical segregation: the proportion of female students (55%) and graduates (59%) exceeds that of male students, but men outnumber women among PhD students and graduates (the proportion of female students drops back to 48% and that of PhD graduates to 45%). Furthermore, women represent only 44% of grade C academic staff, 36% of grade B (associate professor) academic staff and 18% of grade A (professor) academic staff.

At the level of the EU-27, women account for 23% of grade A academics among 35 to 44-year-olds, 21% among 45 to 54-year-olds and 18% among those aged over 55. The situation thus appears more favourable for the youngest generations of female academics but the gender gap is still persistent.

The university educational level and proportion of academic staff by grade among women in Slovakia is rising since the end of the 1990s. According to the statistics published by the Institute of Information and Prognoses of Education [3] in the year 1989 only 0.82% women from the total number of women employed at the universities had academic grade professor in the comparison with the 10.24% of the men. In the year 2009 the percentage of women with the academic grade professor had increased to 7.42% and men to 20.35%. Academic grade associate professor in the year 1989 had 17.49% women from the total number of women employed at the universities and 35.67% of the men from the total amount of the men employed at the universities. In the year 2009 percentage of women with the academic degree associate professor from the total amount of the women employed did not change – 17.51%, but the percentage of the men with the same degree from the total amount of the men employed at the universities decreased to 23.56%. Different situation is with the percentage of women and men with the academic degree PhD. where in the year 1989 it was 75.62% of the women and but only 50.38% of men and in the year 2009 it was 67.84% of the women and 52.19% of men. The situation at four Universities of Technology in Slovakia is expressed in the figure 1.



	Slovak University of Technology in Bratislava	Technical University of Košice	University of Žilina	Technical University of Zvolen
Women prof., assoc. prof., PhD.	372	279	240	89
Men prof., assoc. prof., PhD.	666	538	396	177

Fig. 1. Number of women and men professors, assoc. professors, PhD. at major Slovak Universities of Technology (2009) [3]

There should also be paid attention to the vertical segregation and the access to the decision-making bodies at the universities. For example in 2009 at the Scientific Board of the Slovak University of Technology in Bratislava, there women had no representation and in Academic Senate there were 2 women and 27 men. Figure 2 represents the women participation in Academic Senate and Scientific Board in the 4 Slovak Universities of Technology until March 2011[6], [7].

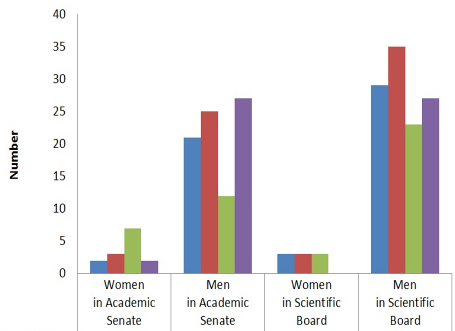
2. THE COMPARISONS OF FEMALE PARTICIPATION IN RESEARCH IN EU-27

In the area of women participation in research [2] the average proportion of female researchers in the EU-27 stood at 30% in 2006 but wide variations were noted between countries: Japan, Luxembourg and the Netherlands respectively have 12%, 18% and 18% of female researchers.

At the top of the country ranking according to the proportion of women in research, there are the Baltic States but also Bulgaria, Croatia, Portugal, Romania, and Slovakia, all of which have more than 40% of women in their research population. Over the period 2002-2008 number of female and male scientists with the higher degree (A, B, C) in Slovakia had significantly changed. As in the year 2002 the total number of women working in the research area with the higher degree was 2467 in the year 2008 it was 4994. For the men it was increase from 4044 in the year 2002 to 6661 in the year 2008 [4].

Women seem to be catching up with men over time as their share of the total research population has been growing at a faster rate over recent years (exceptions are the Czech Republic, Romania, Bulgaria, Hungary, Latvia and France). In the EU-27 on average, the number of female researchers has increased at a rate of 6.3% per year compared with 3.7% for male researchers [2].

This increase of the number of women in research area should be critically evaluated. The Waste of talents: turning private struggles into a public issue Women and Science in the ENWISE countries report [5] put the attention on the pattern where the highest proportions of women are to be found in the countries and sectors with the lowest R&D expenditure



	Women in Academic Senate	Men in Academic Senate	Women in Scientific Board	Men in Scientific Board
Technical University of Zvolen	2	21	3	29
University of Žilina	3	25	3	35
Technical University of Košice	7	12	3	23
Slovak University of Technology in Bratislava	2	27	0	27

Fig. 2. Women participation in Academic Senate and Scientific Board at 4 Slovak Universities of Technology (March 2011)

and the lowest proportions of women are in the sectors with the highest R&D expenditure. This pattern can be standardised so that the respective group behaviours of women and men vis à vis the fields of science and the sectors of R&D can subsequently be examined. A special tool has been developed for this purpose and is referred to as the Honeypot indicator. It quantifies the loss of access to and/or control over R&D expenditure experienced by women researchers en masse because they are more likely to be concentrated in the low expenditure R&D sectors or fields of science. In the ENWISE countries where the overall percentages of women are low (for example, the Czech Republic and Hungary), women's Honeypot scores are negative, signalling that in these countries, women researchers are far more likely than their male counterparts to be distributed in low expenditure sectors. The most negative scores, yielded in the Czech Republic, the Slovak Republic and Hungary, indicate that women are missing out on 16.47%, 15.05% and 9.96% respectively of their expected share of R&D expenditure [5].

3. CONCLUSIONS

According to the above mentioned report this all points to a scenario where women are being used as a kind of secondary human resource to prop up the R&D domains that are of little interest to men, because the reward system is no longer sufficiently attractive. At the other end of the scale, women appear to be squeezed out of R&D where the reward systems are more promising and the stakes are higher. The high proportions of women in R&D in the ENWISE countries therefore signal better news for R&D than they do for women, since women are prepared to perform the same work for less money and under less favourable conditions.

As it is mentioned in [1], [8], the key factors hindering equality in research decision making are: gender stereotypes; the low awareness of gender equality concept, issues, problems and benefits among men and women; the absence of national and institutional strategies and policies aimed at equal opportunities in research and research decision making; work and family balance and choice and societal/cultural expectations.

4. ACKNOWLEDGEMENTS

This work was supported by the FP7-SiS-2008-1 (No 230253), 2009-2011, "Improving the gender diversity management in materials research institutions", acronym Diversity, funded by the European Commission.

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The Concept of Key Managerial Competencies Identification

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Abstract

At present increasingly more enterprises realize the value of their employees. The expert community came to the consensus that the right staff is the most important factor in maintaining a competitive advantage. The enterprises recognize especially the need for high quality managers who are able flexibly react to changes in the market as well as inside the company. In spite of this fact only a few enterprises know what competencies are necessary for their managers. The competency approach markedly influenced all areas of human resource management and provided a new view on possibilities of enterprise performance increase. This approach allows to recruit the right employees into right positions in the enterprises, to utilize more objective rewarding systems, to appreciate own preparedness for reaching strategic goals, to take care of people development in accordance with strategic objectives, to educate managers for future intentions and plans, to optimize employees career development. To carry out this approach, it is crucial to know which competencies differentiate excellent managers from the average ones. This is the reason why this article deals with key managerial competencies identification in emterprises.

Keywords: Management; Manager; Competency; Identification; Performance.

1. INTRODUCTION

Human resources are the most important and at the same time the most complicated resources in each organization. This is due to the fact that through their efforts all other organization resources are "activated". The most complicated human resource issues are due to the fact that emotional concerns cause unpredictable behaviour in organizational management. At present industrial enterprises more and more realize the value of their employees, particularly employees working in managerial positions, because the managers primarily influence in a decisive way the level of their competitiveness. This is the reason why enterprises should know what knowledge, skills, and abilities their managers have for reaching long term sustainable development [1]. In the professional literature it is possible to find more characteristics for a successful manager, but these ones are too general to be applied to maintain the success in particular conditions of the specific enterprises.

2. THE COMPETENCY APPROACH TO HUMAN RESOURCE MANAGEMENT

Probably the most effective method of human resource management in industrial enterprises is utilization of the competency approach. The competency approach has remarkably influenced all areas of human resource management and has offered new insight into the possibility to improve enterprise performance [2].

The basic prerequisite for application of the competency approach is identification and precise key competency definition for enterprise managers.

3. KEY MANAGERIAL COMPETENCIES

The term competency is not clearly defined in professional literature because there is missing agreement what the competency is and what does it consist of. It is caused by the fact that the different authors approach to definitions of this term from various points of view. Moreover, from the point of view of intercultural dimensions it is necessary to realize that in various languages the term competency has various meanings.

For research purposes as carried out in conditions of industrial enterprises in the Slovak Republic in 2010- 2011 and for the needs of creation of an identification procedure for key managerial competencies, we have used the following perception/understanding of the individual term **key managerial competency (KMC)**: a combination of knowledge (a complex of accumulated cognitions), skills (specific abilities to carry out specific activities), attitudes (steady ways of behaviour which are created on the basis of experience) as well as personal characteristics (a complex of intelligence, emotional and physical properties) used by the employee in his/her work and enabling him/her to achieve excellent (above standard) performance. Such performance exceeds average performance of the defined group of managers at least by the value of one standard deviation.

4. THE IDENTIFICATION OF KEY MANAGERIAL COMPETENCIES

Following the research of this problem in specific conditions of industrial enterprises operating within Slovakia, it is obvious that the stated subjects do not have enough information on competency approach. This is the reason why many enterprises have not identified the competencies for managerial positions. On this account, the focus was placed mainly on creating a methodical procedure of KMC identification. These competencies secure the excellent performance of a manager in particular conditions of a specific enterprise. The main goal was not to create a strict (unified) procedure of identification, but to provide a base methodical frame where all the suggested steps of identification are detailed. These can be adjusted by the enterprise following its own specific conditions. KMC identification progress in the particular conditions of industrial enterprises will be influenced by the enterprise culture and the intention of utilizing the identified competencies [4]. The competency model will be made using the managerial key competency identification output. This model will consist of those competencies that are necessary to reach the excellent performance of a manager at a particular position. The suggested procedure consists of 10 steps (phases) presented in Fig.1

The whole KMC process needs to come out of the **overall strategy and the personal strategy of the enterprise** (0 phase), so that the competencies can be identified and lead to meeting the enterprise strategy as well as reaching the long term goals of the enterprise.

The first step of this process is the phase of **planning the KMC identification process** (1st phase). This phase is a critical aspect because it leads to definition of all determining questions of identification and it presents a base for successful application of identified KMC into practice. Within this step it is necessary to define the goals of identification, gain the support on the part of management, particularly those who will be involved in the identification. Moreover, it is necessary to create a team for the KMC identification process and to set the communication plan.

The next step of KMC identification is **to set the performance criteria** (2nd phase) that would be instrumental to define the effective performance measure on managerial positions. Within this step, it is necessary to set the criteria of performance for managerial positions that will include reliable data reflecting the enterprise's performance management, so-called hard criteria (sale, profit, productivity, if they exist for the given work place), but also for so-called soft criteria (criteria of the manager's behaviour-willingness to assume risk, cooperation, flexibility, relationships with the colleagues,...).

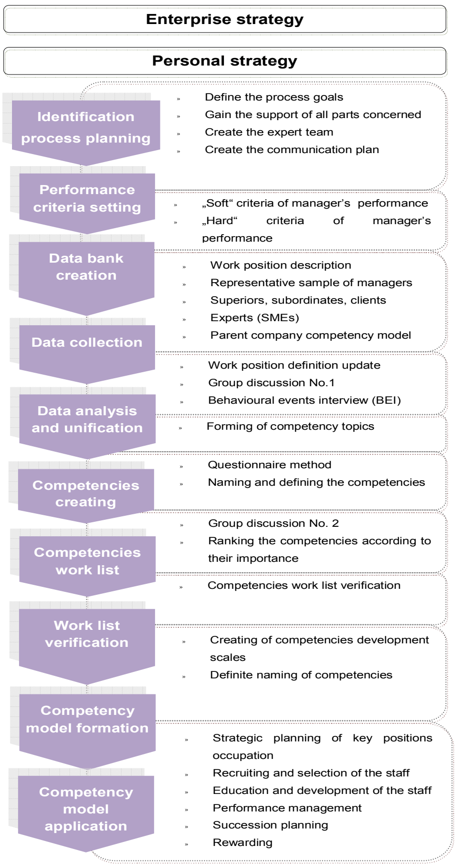

Fig. 1. The concept of KMC identification

In the third phase of this procedure, it is necessary **to create a kind of data bank** that will be instrumental to gain the information necessary to identify KMC in the particular enterprise. The data bank may contain e.g. the working position description, a representative sample of managers, relevant employees, clients, and experts (SMEs - subject matter expert), a parent company competency model and so on. Inserting and utilising the individual data sources will be dependent on the defined goals of KMC identification and on the managerial positions for which the competencies will be identified by the enterprise. Data source options will be influenced by financial and time sources selected for the whole process.

While identifying the KMC, there should be at least two **data collection** methods used (4th phase). If the data collected by one method is similar to the data collected by a different method, there is greater credibility and certainty that the KMC will be identified exactly. According to experts in the field of the competency approach, the most suitable methods to reveal managerial competencies are: a structural interview (BEI, RGI), panel and questionnaire methods [5], [6] .

In the fifth phase, the **data** gained by means of the data collection method will be **analysed** so the behaviours could be identified, particularly those that differentiate excellent managers from average ones. The results of this step will present grouped related behaviour occurrences that will form the basis for outlining KMC.

In the sixth phase, the expert team will rework these grouped behaviours and **create definitions of competencies** so that they can describe as exactly as possible the behaviour which each given competency characterises.

In the next phase (7th), **the list of competencies** important for managerial positions will be formulated using the competency glossary, with the help of discussion group No.2. The goal of this discussion group will be the creation of a list of competencies that differentiates the excellent managers from the average ones and ranks them according to importance concerning the excellent performance reaching a given position.

KMC list proposal should be **verified** by experts from the given field(8th phase). The authors recommend to use the questionnaire form for this verification. The output of this step will be presented as a list of KMC ranked according to their importance to reach excellent performance and they will form the base for creating the competency model.

For each managerial competency, there should be examples of behaviour created on different levels (9th phase). At the end of this step, the competency will be definitely named. . Consequently each competency will be definitely named. Creating of behaviour descriptions is recommended in the form of evaluating levels of development for each KMC. Firstly, the negative behaviour utterances will be described within the competency and consequently, the utterances that show evidence of high level of the competencydevelopment. The highest & lowest level of given competency developmentwill be defined. Title should present the short and total utterance ofbehaviour forming the core of the competency [5].

The value of the identified KMC consists in their application to the personnel processes of a particular industrial enterprise. This value is maximized if the competencies are implemented within all personnel processes. For this reason, the last step of KMC identification (10 th phase) is presented by **application of the created competency model into personnel processes.** This model describes the way to implement the competency model into the personnel processes on the basis of the stated methodology. Personnel processes are the following: strategic planning of the key position occupations, recruiting and selection of the staff, education and development of the staff, performance management, succession planning, and employees' rewarding..

To make the created competency model a real tool of industrial enterprise performance increase, the key competency list needs to be updated according to the enterprise strategy and the other key factors of changes. In conclusion of the whole KMC identification process, the expert team needs to set the schedule of the competency model examination. In case there are no distinctive changes in the given enterprise, group discussions or questionnaires may be used to update. If the managerial positions change markedly, or expressive changes come into being within the enterprise, it is necessary to perform a new process of KMC identification.

5. CONCLUSION

The main goal of creating the KMC identification procedure in the conditions of industrial enterprises operating within the Slovak Republic was to set the conditions for long term achievement of the enterprise performance required. Demand for creating such a procedure also came from the finding that industrial enterprises in Slovakia do not have enough information on the competency approach and its contribution. At the same time, nearly half of the enterprises participating in the above mentioned research displayed interest in KMC identification and creating of competency models. The suggested recommendations form a methodical frame to identify KMC that could be adjusted by every enterprise according to its own specific conditions. Successful application of this procedure can help the stated subjects to succeed in the competitive struggle and, at the same time, reach long term sustainable development through their own employees.

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Company culture and applying of principles of quality management in the industrial enterprises

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Abstract

Building of effective company culture is condition of building of the environment, in which is operating system of the quality management. Company culture as a complex of values, basic assumptions, approaches, premises and norms influences the behaviour of employees. Managers of the enterprise have to be positive example for behaviour and acting for employees, managers on each level of the company structure not only at the top management. Behaviour of the employees is important for successful and effective application of elementary rules of quality management. Overall capacity of employees we can achieve via common values, mutual trust and possibility of self-realization. This article is written on the base of the research focused on situation in the area of quality management in the business practice in the Slovak Republic. Questioner research was done in several sectors of industry in the companies with various sizes and structure of production. The goal of the article is presenting part of results of the research with focused on company culture and applying of principles of quality management in the industrial enterprises

Keywords: Company culture; Quality management; Employees; Managers.

1. INTRODUCTION

Increasing pressure on competitiveness, innovations and reducing costs is forcing businesses and organizations to use effectively and efficiently resources and power potential which is available for them. Quality Management system is a tool for achieving the goals of the company in terms of quality as well as in raising consumer confidence. The current approach to quality management system is based on principles which were specified on the base of experience, good practices and approaches of important representatives in the field of quality management. There were defined eight principles which nowadays create the backbone of the quality management system implementation:

- focus on the customer,
- leadership,
- involvement of workers,
- process approach,
- system approach to management,
- decisions based on facts,
- mutually beneficial relationships with suppliers,
- continuous improvement.

The organization has to develop such quality management system, which will solve the problem areas relating to the above eight quality management principles. Management of the organization has to demonstrate the ability and commitment to quality improvement. The key stone of the organization are workers at all levels and therefore it is necessary to be fully involved and use skills to benefit the organization. Motivating factor is the policy of quality which is adopted by senior management via a form of declaration. Executives promote the unity of purpose and direction of the organization. They have to create and maintain the internal environment in which the workers could be fully involved in achieving organizational goals. [3]

For managing the company may be in principle used so called hard or soft approaches, using the structural embedded hierarchy of control, and formal stated sanctions, or vice versa value consensus of staff the self-regulating abilities of the working groups based on the informal impact. Under the traditional distinction of authoritarian, liberal and democratic style of management; may the employees feel above themselves the "solid", "invisible" or "soft hand". Depending on the chosen, addictive or surviving attitude to subordinate is usually formed the overall strategy and the resulting cultural characteristics of the company [4].

Every manager has his own style, but it is affected by an organizational culture that can create the prevailing style of management, representing generally expected and accepted standards of managers' behaviour .

ICCA (Institute for Corporate Culture Affairs) answers the question: what the corporate culture is. „Corporate Culture comprises the attitudes, values, beliefs, norms and customs of accompany, defining the way it acts in all its business operations as well as toward its stakeholders. A company's corporate culture is the result of an evolutionary process, being established throughout its history and formed through its leaders' beliefs and attitudes. As such the culture of a company influences every step the company takes and therefore represents its only instrument for survival. The questions remain of how to translate corporate culture into everyday business activities successfully. "[5]

2. METHODS USED FOR RESEARCH

In the period of 2008 and 2009, we implemented in the project VEGA the survey which was conducted by the questionnaire method .We assessed the level of fundamental principles application, on which the quality management systems are conceived. It was attended by 135 organizations from various industries. 87% of surveyed organizations had implemented a quality management system and 13% had no system implemented. 23% from the questioned companies were small businesses, 30% medium and 47% large businesses. Questionnaire was created on the base of the requirements of normative documents for quality management system focusing on the application of the eight basic principles of quality management. This article presents partial results of the survey, focusing on corporate culture.

3. THE ROLE OF MANAGERS IN SHAPING THE CORPORATE CULTURE IN ACCORDANCE WITH THE QUALITY MANAGEMENT SYSTEM

The environment where employees are actively involved in meeting the objectives and developments in the organization and quality management system which fully works is created by senior management by leadership and management activities.

Managers of organizations must lead the people and create such environment that all groups of employees will work with maximum output in order to fulfil intended objectives. The implementation of leadership principle in an organization requires:

- declaration of vision, policy, objectives of the organization in accordance with the customers and stakeholders requirements
- creating the working environment of mutual trust between employees and management,
- providing opportunities to employees for own active and creative work, including the identification of responsibilities and powers,
- the employees incentives for teamwork and improvement .

Very important fact is the attitude of the company management itself, whether they will use and how they will use the documented quality management system in their favour. The implementation of quality system brings the changes that relate to people and their work, so its implementation is not simple. It is necessary to create the adequate conditions in the organization, to motivated people properly, to create a creative atmosphere, to promote a teamwork and communication. [1]

The primary mission of the work of manager - a leader is to systematically manage the work of others to ensure achievement of organizational goals via subordinates. Manager not only manages the work of others, but he is also responsible for the results of their work.

Leadership style often referred to as a management style is characterized by an approach that managers use when dealing with people from their teams.

The mission of manager is primarily to ensure that the objectives of the organization will be fulfilled and to develop human potential in the organization. In fulfilling this mission is important to be worthy for others to follow and thus motivate staff.

The survey carried out by the question about the perception of managers in organizations in Slovakia with the established quality management system, we found (see Figure 1) that in 66% of organizations the managers are perceived as authority in attitudes and behaviour, which is important in terms of meeting the principles of leadership.

People usually follow that about whom they believe he might help them meet their wishes and aspirations and satisfy their needs. In order

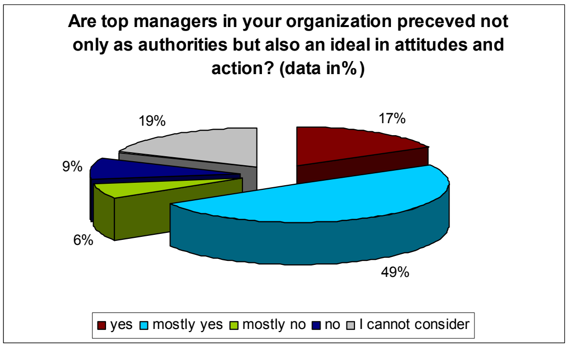

Fig. 1. Acceptance of managers in organisation

to be the manager able to lead people effectively, he must understand why they behave in a certain way, what motivate them and to choose such methods and approaches which raise the willingness of the workers to work and regulate their behaviour to desired direction – to choose an effective way to motivate workers.

Every business has its purpose, its goals. Leaders connect efforts of members, co-workers, employees of the company to realize the assessed goal. If they want effectively manage people, they have to use not only managerial skills but also leadership skills. The problem consists in the proper application of both types of skills in a given situation to achieve a successful outcome [2].

Leaders develop culture of the organisation; they direct resources and objectives of the organization to excellence. Leaders give the organization the direction. They motivate the employees in the organization by acting as an ideal also via exemplary behaviour that is consistent with the expressed and implied values.

4. THE INVOLVEMENT OF EMPLOYEES AND CORPORATE CULTURE

The total potential of employees can be used for benefit of the organization through shared values, by fostering mutual trust and facilitating initiatives. Staff involvement and communication with them enables using their skills to benefit the organization.

Corporate culture as a set of values, attitudes, thinking patterns, and ideas is expressed and is observed in the behaviour of employees. If the management tries to influence and shape the behaviour of employees to desired direction, it is important to deal with the corporate culture. In the survey there was a question: whether the organization clearly defined objectives in building corporate culture. The results point to the fact (see Figure 2) that this issue is examined in the companies, even though that from the total number up to 42% of respondents indicated that clearly defined objectives for building a corporate culture were defined only partly. More attention is paid to issues of corporate culture in large and medium-sized companies. Small businesses in the 27% reported that they have not clear objectives in building a corporate culture.

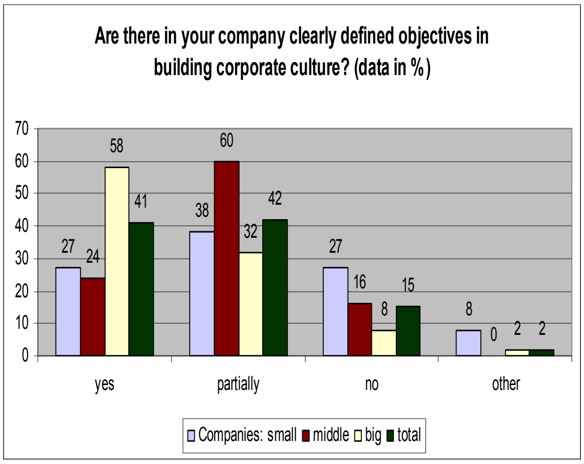

Fig. 2. Defining objectives in corporate culture

5. CONCLUSIONS

Managers in organizations have to deal with the new role of leader as an ideal of behaviour, an ideal of attitudes and values.

The important and irreplaceable role in the process of obtaining commitment and loyalty of staff has the behaviour of superiors, their role of pattern for other employees and in especially the value that is in the organization attributed to human resources.

It is important that crucial business objectives and priorities, ways and means of achieving them have been accepted by all employees. While the unity of common values and standards are still predominate over the differences and inconsistencies, then we can talk about a strong corporate culture [4]:

- mediates and facilitates a clear view of the enterprise and makes it for employees transparent and relatively easy to understand,
- creates the conditions for direct and unambiguous communication,
- enables quick decision- making,
- accelerates the smooth implementation of (plans, projects, programs, decisions...),
- reduces demands for control of co-operators,
- increases motivation and team spirit;
- ensures the stability of social system.

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IRRATIONAL FACTORS OF INVESTOR BEHAVOUR: DETERMINATION AND ESTEMATION

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Abstract

The investor behavior in the market is not rational, so assumptions upon the majority of economic theories are based are violated. The paper identified the main causes and factors of irrational investor behavior, with which it is possible to analyze and control its behavior. To determine the impact of subjective factors on the propensity to risk there are used methods and models of artificial intelligence. The results of the simulation used to construct the utility functions of the investor, which is required, for example, to make investment decisions.

Keywords: Irrational factors; Utility function; Modeling.

1. INTRODUCTION

Studying of investor's behavior in conditions of uncertainty and risk allows to reveal one of fundamental factor "propensity to risk". Propensity to risk is a relative parameter which is difficult to estimate and to determine its optimum level. The understanding of these factor, studying the factors influencing on it, will enable to find a necessary toolkit to consider an investor's irrational behavior. For the decision of this problem it is necessary, firstly, to reveal principal causes of irrational behavior to analyze and supervise similar situations and as a result to avoid negative consequences of the "incorrect behavior". Secondly, it is necessary to predict in time and objectively to estimate actions of the other participants, using any deviations from a "rational" behavior.

In the work the analysis of various ways of the described problem has been made. A set of the subjective factors which determine the investor behavior in the market has been revealed. An algorithms and models of artificial intelligent is used in research.

2. IRRATIONAL FACTORS OF INVESTOR BEHAVIOR

A study of investor behavior under uncertainty and risk reveals a number of laws, by which it would be possible to act on one of the most fundamental factors "". Propensity to risk - a relative measure, which is difficult to quantify and determine the optimal level. To manage effectively the characteristics of "risk tolerance", it is necessary to determine the influencing factors, to pick up the necessary tools with which may affect the irrational investor behavior.

To solve this problem, firstly, to identify the main causes of irrational behavior, with which it is possible to analyze and control such situations as a result of avoiding the negative consequences of inappropriate behavior. Secondly, it is necessary to objectively evaluate and predict actions of other market participants (partners, competitors), by any deviation from the rational course of action.

The authors have analyzed the different ways to explore the irrational behavior of economic agents as a result of which revealed a lot of subjective factors that determine the behavior of investors in the market, which can be divided into two groups. The first group can be attributed an erroneous perception of reality or incorrect assessment of the real situation and, therefore, wrong decisions due to stereotypes of thinking, common to almost all investors in any industry. The second are emotional factors that determine the behavior of an investor with risk and uncertainty.

One of the major problems associated with understanding of investor behavior in the market, is to study ways in which it selects, analyzes, and interprets the information available to him, and then uses it to form their principles and beliefs. There are three main situations that lead to produce incorrect estimates in the future to irrational actions:

1. Revaluation of available information. If the investor owns the information that corresponds to the prevailing stereotypes about him any events, phenomena and processes, their causes and their future implications, he begins to give this information too high (even when this information does not bring any good to make the right decision) and really ignore the significant factors. Often the impression that there is some relationship between events and phenomena are not linked.

2. Improper use of intervention models in probability theory and mathematical statistics in the evaluation of reliable and relevant information.

Well founded and often presented adequate assessment resulting from the application of mathematics, namely, probabilistic and statistical methods. This raises a number of misconceptions that lead to unwarranted conclusions. The reason for this phenomenon is that in attempting to estimate the probability of occurrence of one or another of several possible results, economic agents typically rely on representative statistical samples.

3. Influence in shaping the evaluation of methods describing the situation and provide information. Investor psychology in the perception of the information available is that different ways of reporting are to receive different ratings. For example, if one want to evaluate some final value based on the submitted data for visual perception, lower values will be given where there were fewer challenges in the early numbers.

The essence of the factors presented as follows:

1. Expected return. Preference is less income, but "certainly", i.e. with 100 percent certainty, more income, but with a lower probability of receipt.

2. Accounting for differences rather than similarities. Simplifying the choice between different perspectives, investors ignore the similarities, focusing on the differences. This may lead to different preferences in similar situations, if there are several options for expansion prospects are the same and different components.

3. Non-linearity of preferences. With increasing amounts of potential gains or losses smoothed value equal to the absolute value of the difference between these amounts.

4. Giving a higher value growth than the absolute value of the factors. Investor receives in varying degrees of the absolute value of its wealth and its changes, with losses always seem more important than an equivalent income. Investors are more inclined to take greater risks to avoid losses than to gain additional profit.

5. Rejection damages. Negative emotions investor experienced in relation to losses far more positive emotions associated with making a profit. Investor attaches greater importance to losses than gains.

6. The use of incomplete and inaccurate information. In certain situations, investors are taking the limited information for the exhaustive and comprehensive. This leads to its misinterpretation and, consequently, to inefficient decision-making.

7. Factor determination. Investors are likely to see pattern where there really is a coincidence. A similar situation occurs when several similar events produce conviction in the frequency of the phenomenon.

8. The tendency to simplify. If the complexity and uncertainty of the situation increases, the investor loses rationality and begins to use the simplification. Because of the difficulties of processing large amounts of complex information of this information can be lost, resulting in a simplification of the problem.

9. Subjective assessment of probabilities. There is a difference between the actual

probability of the event and the way investors evaluate this probability.

10. The factor of "slow" change. Greater weight is given to the general, rather than absolute changes. Investors may not take into account non-standard behavior of the system, if it occurs gradually, with certain intervals of time.

11. Factor greater significance of recent events. The most recent events are usually given much more weight. Investor may feel that the project is not sufficiently effective after a series of losing trades, but in reality it remains within the estimated ratio of profits and losses.

12. Low tendency to change targets. The essence of this phenomenon lies in the fact that in the subconscious of a conflict between the investor beliefs (assumptions) and reality. To avoid it, the subconscious mind allows the contradictions, "tune" the historical facts under existing beliefs.

13. Biased assessment of the assets. The tendency of investors to seek higher price for what they own, compared with an estimate of the property of others. This effect is quite pronounced on the example of selling a business, which is estimated on the basis of the effort and resources on starting a business, not taking into account the economic performance and the value of similar assets.

14. Risk propensity depends on the previous financial results. The degree of risk aversion depends on past investment results.

Identified effects and patterns of behavior under uncertainty and risk, explain many facts of irrational behavior of financial market participants. Irrational behavior in particularly appear in situations of uncertainty and risk in business, investment, financial activities. Propensity to risk is one of the most important factors in the implementation of innovative investment projects.

3. ESTIMATION OF UTILITY FUNCTION

One of the major unsolved problems of modeling decision-making process in the economy is the problem of subjectivity, which is not described by classical mathematical methods. To solve some problems of utility functions are used. In analyzing a decision on financial cottages on the behavior of a manufacturing plant of an economic subject is studied on the basis of rational choice theory. This is because it is based on this approach generated optimization model. Rational is behavior which provides the best decision in terms of a particular purpose. As shown above a number of decisions based not only on rational considerations, but also in social traditions, subconscious reactions, moral installations scattered facts of personal experience in this or a similar field, etc., and are the result of irrational behavior. In the situation of high degree of uncertainty economic agents are not able to analyze the whole complex of factors and goals, and often enjoyed special strings fragmentary discourse.

Classical analytical approach used in the analysis does not involve consideration of subjectivity in the decisions not investigate reasons and methods of mutual influence in the construction of economic evaluations. To solve the problem of selection decisions on investment strategy, taking into account the different propensity to take risks for potential investors can use tools based on the construction of the utility function of Neumann-Morgenstern. To construct a utility function it is necessary to determine how the nature of the behavioral study of alternatives influences on the functions type, as well as consider the impact of subjective factors.

Practical application of utility theory in assessing the investment attractiveness of projects identified the following advantages utility curve:

1. Utility curve, as the expression of individual preferences of the investor, being built once, can make investment decisions in the future, taking into account their preferences, but without any consultation with him.

2. The utility function in general can be used to delegate the decision-making. It is logical to use a utility function of top management as to ensure its position in the decision it seeks to take into account the conflicting interests of all contractors. The utility function may change over time, reflecting the financial terms.

Because of the complex cause-effect relationship of subjective factors, irrational behavior, and risk propensity to determine the impact of factors is appropriate to use artificial intelligence methods. With the help of fuzzy set theory the model was developed which allows to analyze and evaluate the impact of subjective factors, investors' risk propensity for acceptance of administrative decisions.

The implementation of fuzzy model is carried out in Matlab environment using the module Fuzzy Logic Toolbox. The results of the simulation are used in construction the utility functions of investment projects. The input data serves subjective factors. Initial data processed by the system and generates an output variable is the risk propensity. All variables in the model are normalized in the interval from 0 to 1. As shown in Figure 1 the curve that determines the dependence of the "Profit" and investors' risk propensity, has 3 zones.

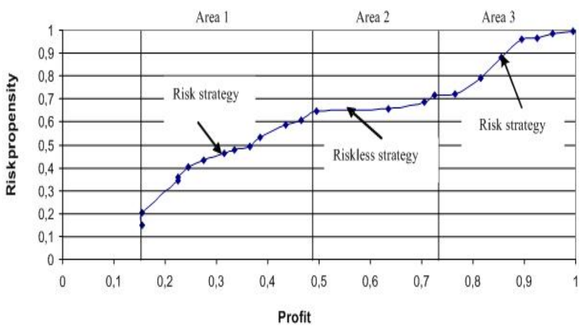

Fig.1. Utility function

Area 1. Strategy of risky investment. With the increasing of the profit the risk propensity has the tendency of significantly increased. Changing the low profits significantly affect the decision.

Area 2. Strategy of risk-free investment. With the increasing of the profit the parameter "addiction to risk" is practically unchanged. The mean change in income has little effect on the decision.

Area 3. Strategy of risky investment. With the increasing of the profit the risk propensity has the tendency of significantly increased. Changing the high profits significantly affect the decision.

4. CONCLUSIONS

Thus, based on fuzzy model determined the degree of influence of subjective factors on the risk propensity. The results were used in construction of utility functions of investment projects, taking into account the influence of subjective factors on the tendency of decision-makers to take risks.

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Inventory management as a method of retailer's efficiency improvement

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Abstract

In a market trading enterprises in implementing their activities often have to take risks. Especially the risk increases when managers operate without the use of his work scientifically sound approaches to business management, in particular, inventory management company. Typically, heads of business enterprises are weak accounting costs associated with storing, transporting goods and the amount of purchased goods is often associated only with the available storage capacity. However, to increase the competitiveness of commercial enterprises require a comprehensive approach in managing its inventory, accounts for the influence of many different factors.

If we talk about minimizing costs, the increase in the size of shipments leads to increased costs associated with its storage. Reason for this may be a few: limited storage space, the scale of demand do not match the volume of offers, etc. Therefore, the company is interested in buying so many goods that would not be increased levels of expenses. Consider the inventory management at the retailer by the example of the shoe industry.

Keywords: Various operations; Cost management; Efficiency improvement.

Decisions taken at the stockpiling, directly affect three types of costs that must be assessed and minimized:

1. The costs associated with transportation, insurance and customs clearance of goods (if the goods purchased outside of Russia). The magnitude of these costs depends on the basic conditions of supply of goods as specified in the contract, as well as on the amount of purchased goods. The basic terms of the deals - the basic rights and obligations of parties to the transaction, depending on the conditions that determine the position of the cargo relative to the vehicle (delivery, payment of transport risk and security of cargo). For example, Pickup (ex works) - the seller releases the packaged goods from the warehouse, all costs associated with transportation of the goods, insurance and payment of customs duties, if necessary, shall be the buyer.

Transportation shoe can be done in different modes. If this is used to own a car, travel expenses include:

a) the cost of purchasing petroleum products;

b) the accrued depreciation the car;

c) the costs associated with repairing the car;

d) pay the driver and the freight forwarder;

e) travel expenses (hotel, per diem, expense accounts).

The costs of transporting shoes rail include costs associated with renting a container, delivery of cargo to the loading - unloading, the loading - unloading shoes.

If the shoe is transported by plane, then the costs associated with this include the cost per kilogram of cargo.

The composition of the costs of establishing stocks of shoes also include the cargo insurance at the time of its carriage (which is costly).

When the goods are purchased outside of Russia, traders should make clear the goods, unless otherwise stipulated in the basic terms of delivery stipulated in the contract. Until the moment of customs clearance procedures shoes must be placed on an interim customs warehouse storage.

The amount of customs duties is defined as follows: the basis of a sum of goods in the currency specified in the Declaration (1). This amount is charged the cost of customs procedures (2). Thereafter, in accordance with the code of goods shall charge customs duties (3). On excisable goods is charged the amount of excise tax payments (4).

The customs value of goods = ((1) + (2) + (3) + (4) +% VAT.

2. The costs associated with storing the goods in the store, they include:

a) the rent - a payment for use of the leased property;

b) the maintenance staff (storekeeper, porters, cleaners), which includes the salaries of all deductions (pension fund, social insurance fund of compulsory medical insurance);

c) the property tax and other fees, depending on the value of the stock;

d) Costs associated with falling stock values because of aging, damage, theft;

e) the cost of capital invested in stocks;

f) the cost of heating, lighting, storage space;

g) The cost of acquisition and maintenance of warehouse equipment, protective clothing (depreciation on fixed assets and low-value consumable equipment and protective clothing).

These costs depend on the size of inventories and the duration of their storage. 3. Losses arising from pent-up demand caused by the absence of a particular type of footwear. This, above all, the lost volume of sales or lost customers.

Costs associated with the creation, storage and replenishment will depend on the size of the party purchased shoes, but also on how quickly realized commodity. Therefore it is expedient to minimize the costs right choice of brought in goods, taking into account its implementation.

Thus, the losses U, associated with the stockpiling of goods should be assessed the sum of the cost of transportation of goods from producers to Zпер warehouse for storage of goods Zxp to its implementation and the loss of unmet demand, $\pi_{нс}$

$$U = Z_{пер} + Z_{xp} + \pi_{нс} \tag{1}$$

Each term is evaluated with respect to a certain segment of time during which it is planned to realize the volume of goods purchased. It is advisable to take equal to one month, as is the frequency of summarizing the financial results. The challenge is to determine a size n of the acquired party in the existing restrictions on the storage area, at which the minimum loss of U.

All terms on the right side of (3.7) depend on the value of the purchased consignment. And the functions Zпер(n) and Zxp(n) are increasing and the function - is decreasing.

Consider the function $Z_{пер}=Z_{пер}(n)$. It can be represented as

$$Z_{пер}(n) = Z^*_{пер} + F(n) \tag{2}$$

where - the cost of maintaining facilities and professionals who provide a dispatch of goods from the producer or distributor and wholesaler to a retailer for storage and sale. In some range n this component costs for transporting goods from the amount of the acquired party is independent, the function F(n) characterizes the shipment costs, depending on the number of items shipped. Function has often stepped form, as transportation is usually done in batches. In some cases we can take $F(n)=C_{пер}n$ and assume

$$Z_{пер}(n) = Z^*_{пер} + C_{пер}\, n\,. \tag{3}$$

Here $C_{пер}$ - transportation cost per unit of goods.

Now consider the dependence of the volume of the acquired storage costs Zxp(n). These costs are determined by the cost of storage Cxp unit price for units of time depending on the number of n_k units stored in the k-th segment and the total storage time t:

$$Z_{xp}(n) = \sum_{\kappa=1}^{m} C_{xp}\, n_k\, (\Delta\tau)$$

where $m=t$: $\Delta\tau$. If we take $\Delta\tau$=1, then

$$Z_{xp}(n) = \sum_{k=1}^{t} C_{xp}\, n_k\,. \tag{4}$$

Denote $a(\tau)$ the number of items, realized by τ - unit segment, n_0 - volume available to the beginning of the reporting time period t. Then

$n_k=n_{k-1}- a(\kappa)$, and

$$Z_{xp}(n) = \sum_{k=1}^{t} C_{xp}\,(n_{k-1} - a(k))$$

It is evident that, so

$$n_{k-1} - a(k) = n_0 - \sum_{\tau=1}^{k} a(\tau)$$

$$Z_{xp}(n) = C_{xp}\sum_{k=1}^{t}\left[n_0 - \sum_{\tau=1}^{k} a(\tau)\right].$$

Denote $\Phi(a(\tau), t) = \sum_{k=1}^{t}\sum_{\tau=1}^{k} a(\tau)$ (this functional characterizes the dynamics of the sale of imported goods in the shop), then

$$Z_{xp}(n) = C_{xp}\left[tn_0 - \Phi(a(\tau), t)\right]$$

.

This ratio relates the cost of commercial enterprise for storage Z_{xp} goods at time t with the cost of Cxp storage of one commodity unit per unit time, with the initial volume of goods n0 and functional dynamics of sales Φ.

In addition to costs associated with storing the acquired party goods, one must consider the costs associated with the contents of storage (warehouses). Denote these costs through Z_{xp}^*. They are constant, as there are with empty stores. This component of the size of the acquired party is independent, it must be added to the right side of 6 .

Now consider the third term losses (1) associated with providing a stock of goods - π_{HC} a loss of pent-up demand, which occur when the delivery was such that the total n_0 goods to the top of t was less than n_c, who took the time t. Then we can write

$$\pi_{HC} = C_0(n_c - n_0) \ ,$$

where C_0 - selling price per unit of goods this form.

Total losses

$$U=a_0+(a_1-C_0)n_0 \ , \qquad (5)$$

where

$$a_0 = Z^*_{nep} + Z^*_{xp} - C_{xp}\Phi(a(\tau),t) + C_0 n_c \qquad (6)$$

$$a_1 = C_{nep} + C_{xp}t.$$

From (3.11) implies that the dependence of losses from U of stock n_0 determined by the difference

$$a_1 - C_0 = (C_{nep} + C_{xp}t) - C_0 .$$

If the difference is greater than zero, then the function $U(n_0)$ increases and decreases if the opposite. This means that if the sum of the cost of transportation and storage costs for t one unit of a commodity exceeds its price, the increase in the amount of purchased goods contributes to increased costs and losses, if otherwise, then provides them with a drop. This conclusion is derived by taking into account not only the actual costs, but also the unfulfilled possibilities of the market demand. Accounting sense, it is necessary in problems of allocating scarce resources trading company for the purchase of various goods. Losses (5) and have a constant component a_0 (6), does not depend on the amount of purchased goods n0. It is determined by fixed costs for transportation and storage, as well as the dynamics of sales of goods and the number of n_c (in accordance with market demand) during the survey period of time t.

In the special case where

$$C_{nep}+C_{xp}t=C_0$$

This means that the costs of establishment and maintenance of a stock of goods on the volume does not depend on if the transportation cost per unit of goods and storing it within a specified time t offset by selling price.

Profit commercial enterprise depends significantly on the cost-formed transportation of goods from the place of purchase and storage in the enterprise. Volumes of these costs depend on the number of imported goods, and, more imported, the greater the cost. Maximum capacity is limited storage space. There is also a lower limit: a small amount in storage can lead to a backlog of demand, to the missed opportunities. Therefore, when assessing the costs associated with the creation of a stock of goods should take into account three terms: the transportation costs, storage costs and losses from the pent-up demand.

It is shown that there are some conditions under which the total (three components), losses on the number of stocks of goods does not depend - is the cost of transportation and storage unit price equals the price of its sale.

Optimization in process efficiency in industry company as an equipment of company permanent sustainability assecuration

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Abstract

The subject of this contribution is exploring of influence in process complex optimization of integrated supply chains of industry company, in market conditions which are from point of permanent sustainability of company logistics system changing. The proposal of methodology for process efficiency optimization of integrated supply chains in logistics company systems from point of assecuration the permanent sustainability and its verifying in concrete conditions.

Keywords: Optimization; Process efficiency; Industry company; Permanent sustainability innovation and investment projects; Risk analysis; Project sustainability.

1. INTRODUCTION

It is often necessary to propose an efficient process change or changes which can bring the highest gain rate of the profit production in the logistics chain. The contractor knows the interval of the process change planned (time and costs data) in the logistics chain and looks for the maximum benefit of the process change proposed.

The issue mentioned can be dealt with by the OPTIproc program OPTIproc [1], [2], [3], [7].

OPTIproc program consists of three modules:

- **VSudaj** (input data of the logistics chain),
- **OPTpro** (entering the interval of process parameters changes in the logistics chains and their optimization),
- **MAXpri** (determination of the gain rate of the profit production for individual processes changes variables and their evaluation)

In OPTpro module the assumed intervals values of costs and time changes of the logistics chains processes are entered. In the first step the PMF (Project Management Forecast) simulation program verifies and evaluates all the variables within the intervals of costs and time changes entered. Then it provides the results of the efficiency of individual processes changes in the logistics chain including the specific values of the gain rate of the profit production for the logistics chain.

The one who assigns the logistics processes optimization based on the analysis of the results achieved in the first step of the simulation, make the narrowing of the optimization interval of costs and time more precise, i.e. a numerous verification of the process changes variables in the interval given. Simultaneously, it is necessary to determine the criterion of the simulation optimization, i.e. to determine the maximum value of the gain rate of the profit production of the logistics chain change including the criterion weight. The weight of the criterion is substantial by the determination of more criteria for the optimization by the simulation.

The Optimization Step 2 resulted in the determination of the optimum values of the gain rate of the profit production in the logistics chain for the value interval verified. Protocols, graphs and histograms are part of the simulation outcomes, which provide complex documentation for deciding over the implementation efficiency of the logistics, process changes proposed.

2. EFFICIENCY EVALUATION OF THE LOGISTICS PROCESS CHANGES IN THE LOGISTICS CHAIN

There are usually more logistics chains in the company logistics system. Logistics chains can differ only in different parameters of the logistics processes (different scope of the quality check carried out, different product packaging and different labelling) according to the customer´s requirements or different conditions in ordering (BRO) and by the production process structure. They are usually essential differences in the processes of the logistics chains of the logistics system.

The mentioned types of logistics chains are the subject to making the processes more efficient in the logistics system.

To evaluate the efficiency of more logistics chains in the company logistics system LOGRET program [1], [2], [3], [7] is suitable.

It consists of four modules:

- **INdate** (input data of the logistics chains),
- **PROCES** (data processing of the logistics process changes proposed),
- **VALUE** (efficiency evaluation of the logistics process changes proposed in the logistics chains),
- **ACRETI** (calculation of the gain rate of the profit production of the processes changes in individual logistics chains, summarization of the changes benefits in the logistics chains and in the company logistics system). To Indate module all time and costs data of current logistics chains in the logistics system including the goods value supplied by the chain and the gain rate of the profit production are entered.

The logistics process changes proposed in individual logistics chains are reflected in the database of PROCES module. The assumed processes changes are declared by the changes in time and costs parameters.

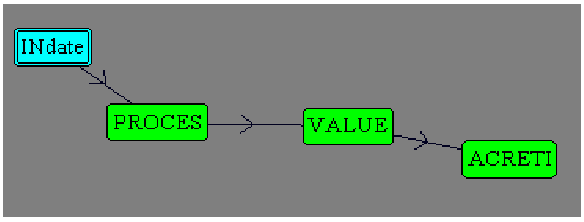

Fig. 1. Structure of LOGRET program

Source: own

It is necessary to mention that if the change of the common logistics process for all kinds of the logistics chains in the logistics system is proposed, we have to reflect the time and cost changes into each of the logistics chains.

There are the basic conditions that every logistics process change proposed has to decrease the total running time of the goods supply to the customer by a specific value ΔCp. The costs item of the logistics process change proposed in the logistics chain ΔNp can have positive, negative or null values.

The logistics process changes proposals with negative costs changes for the process bring the biggest benefits for the logistics system as well as for the logistics chain. These negative values in costs present direct increase of the profit value of the goods supplied by the related logistics chain. For each of the logistics chains the time and costs processes changes are summarized this way.

The efficiency calculation of the logistics process changes proposed in individual logistics chains are carried out in VALUE module. For each of the logistics chains a new value of the profit production and the value of the gain rate of the profit production are determined.

In the last ACRETI program module the values of the efficiency gain of individual logistics chains and the logistics system are summarized. The original value and the value of the profit production are compared for each of the logistics chains. The logistics chain change proposed is acceptable only if it brings the gain in the profit production rate; otherwise the original logistics processes structure with the original value of the profit production rate is valid.

The result value of the logistics system profit production rate with the changes in the logistics chain processes is the sum of acceptable gains of the profit production rates produced by individual logistics chains.

Simulation LOGRET program allows verifying the process changes of individual logistics chains by more procedures, either gradually by individual process changes of the logistics chains, by groups or by summarized all process changes for each of the logistics chains.

The procedure choice of verifying the logistics process changes depends on the structure of the process changes designed and on the extent of logistics processes structure difference of the logistics chains. Either way, by big differences in the logistics processes structure, it is recommended to apply the verification procedure by individual logistics process changes of the logistics chains because of better transparency in the efficiency of the process changes proposed and their influence on the change of the profit production rate in the logistics chain.

The newly proposed logistics process changes in the logistics chains mean gradual parameter changes of the logistics chains processes, however, it is possible to also propose radical process changes of the logistics chains, i.e. a completely new way of the process implementation – some of the processes from the original logistics chain are eliminated and replaced by new processes (in other structure) providing the total increase of the gain rate of the profit production in the logistics chain. It is necessary to know that the set of logistics chains of the logistics system are evaluated, i.e. the radical changes (proposals) can influence the process parameters of more logistics chains. The rules for the efficiency evaluation and for the new way of the process implementation are the same as for the gradual rationalization of parameter processes. Complex efficiency evaluation of the logistics chains set allows strengthening of the synergic influences of the planned process changes efficiency.

The simulation results analysis of the process changes proposed for individual logistics chains show that the new proposal of the process change of the logistics chain has to be verified. The newly proposed change together with required time and costs data are entered into the LOGRET program and then the change or changes are verified.

There can also be the need to verify the efficiency of the process change of the logistics chain in the time and costs interval assumed, i.e. to determine the optimum benefit values of the process changes proposed for the chain or chains of the logistics system in relation to the process changes of the logistics chain or chains proposed in the logistics system.

The answer is to utilize the possibility of the second step of the investigated project modelling and continue with the assignment of the precise interval (optimization interval), minimum and maximum value of the time and costs process change of the logistics chain or chains including the parameter value change by the optimization. The criterion of optimization is also assigned, the variable from the program that will be optimized during the simulation.

LOGRET simulation program allows optimizing more variables during the optimization. The optimization in the simulation means that looking for the minimum or maximum variable in relation to the optimization parameters. If it is necessary to optimize more variables by the simulation, some of them can be maximized, some minimized. This is the case of multi-criteria optimization of the program variables. Obviously by the multi-criteria optimization the optimized variables are not dependant on each other.

To evaluate the efficiency of the process changes in the logistics chain or chains it is sufficient to apply the optimization criterion of only one program variable and maximize the total value of the gain rate of the profit production in the company logistics system.

The optimization simulation of the process changes proposed in the logistics chains of the logistics system results in the optimization protocol including the efficiency order of the process changes proposed for the logistics chains according to the optimization criterion given.

The graphs and histograms of the verified variables are part of the result outcomes and complement the protocol information and contribute to better deciding about the process changes proposals implementation.

There are histograms of the process changes efficiency in the logistics chains of the company logistics system (Fig. 2) and histograms of the process changes efficiency within the individual logistics chains.

The result protocol can comprise more process changes proposals for the logistics chains, which bring the same total value of the gain rate of the profit production in the logistics system. In these cases the histograms of the gain rate of the profit production of the individual logistics chains and histograms of other variables (increase of the customer´s productivity) are very important. They provide better decisions in the selection of the process changes variable implementation in the logistics chains of the logistics company regarding the real company specifications.

Each of the process changes set of the logistics chains in the logistics system requires the implementation of various investment costs, implementation time, and comprise a different logistics processes structure which bring different utilities as well as influence the customer's productivity differently. It is necessary to revaluate all these factors completely and then choose the result variable of the process change in the logistics chains. The maximum increase of the customer´s productivity is the most important factor.

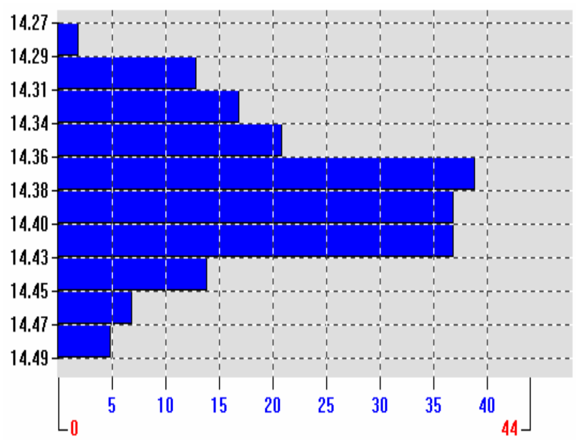

Fig. 2. Overview of the total values of the gain rate of the profit production in the logistics chains of the logistics system

Source: own

PMF simulation program allows transforming the result values of variables into MS Excel, where they can be further processed and included into other sources.

LOGRET program was used in practice by the efficiency evaluation of the process changes in the logistics chains in chosen companies [4]. The activity resulted in the increase of the gain rate of the profit production of the company logistics systems which present the economy of time and costs in the logistics processes, increase of the profit values, decrease of stocks, company cash flow increase as well as the improvement of the customer´s productivity.

3. CONCLUSIONS

Simulation programs on PMF basis allow comparing of any number of change proposal variables of any logistics process within the integrated logistics chain and chains of the company logistics system in terms of time, costs and probability occurrence.

Three PMF based programs – OPTIproc and LOGRET – introduced in the previous part sufficiently cover the efficiency evaluation of the process changes in the logistics chains of the logistics system on the level defined. The program set is open and it possible to enhance it by further requirements, which have to be considered by the efficiency evaluation of the logistics chains of the logistics system.

The input data from the PMF programs mentioned are the processed values of variables in the form of protocols, graphs and histograms in the extent required and ease the decisions on how to make the complex logistics systems more efficient, especially those which consist of more logistics processes and logistics chains. Without applying these programs, the efficiency of the logistics chains processes is very difficult.

It is also important that the simulation provides the possibility to compare the larger number of process changes variables regarding the criteria determined, thus enhancing the information about the subject simulated whose implementation in a different way is time and cost consuming. The results obtained from the simulation are very important since they can be the starting data for the construction of the matrix model of the company logistics system.

First stated programs and progresses are a part of complex progress of logistics processes efficiency optimization in industry company. Its application reached significant economy results in praxis, mainly in industry companies of car industry, what confirmed a rightness and efficiency of suggested process and equipments utilized in its applying.

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Dynamic modelling and ITS utilization in innovation project suggestion valuation

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Abstract

A contribution contains an authors knowledge from applying of dynamic modelling in valuation of innovation projects suggestions. Dynamic modelling allows to achieve a complex bond of projected system, to observe their dynamic and stochastic attributions, including economic attributes and so to catch an influence of their individual processes forvaluation indexes of innovation project suggestion. It allows also an optimization of project variants suggestions, process risk analyses and empiric sensitivity analyses of project variables, what allows reaching another important information and relevant backups for verifying and valuation of project suggestion. Applying of dynamic modelling in chosen projects confirmed its importantness and necessarity for ensurance of serious decision in chosing the project suggestion. Valuation indexes of project innovations in practise achieved positive values.

Keywords: Dynamic modelling; Project suggestion; Innovation project; Risk analyses; Project variants optimalisation.

1. INTRODUCTION

In actual economic situation the production companies and suppliers have to rationalize not only its production and montage units, but also the development and innovation department. According to the available studies for example approx. 10% developed car technologies has a potential to become so called hot new in innovation. But also, technologies which are hot news bring high risks. The higher innovation jump, the higher is the risk. Companies which are in industry have to increase its focusing on the innovation and have to have a sensitive approach to the potential risks in new technologies development. Risks of these technologies influence many market structures, competitivenes and new company models in each segment. Innovation cycles are shorten, and developing costs are insreasing by higher technology complexity.

Directly in suggestion of new innovation projects begin many problems and risks. A big amount of variants and a complexity of its scoring are not used by clasic equipments for projectant not for other workers for choosing the optimal variants of solution. Teh most projects are realized on the base of widen views and crietrias. If the project is too expensive, tehre have to be some edit processes to perform it. Whern the con ditions are not fixed, or there is a high time pressure, bounded financial resources it is hard to talk about total project parameters optimization. Many times happens that tyere are some defaults in the existing project, which dont allow fully usage of all possibilities. After that, during the operation are solving the problems of project changes, what means another costs. In the course of operation there are solving problems with additional project editing, what means additional cost increase. For such cases it is appropriate to apply a dynamic simulation.

2. DYNAMICAL SIMULATION

Simulation is an experimental technology, which basic principle is in making more simple the representation of real system in simulation models, it means taht basic ground is substitution of examined dynamic system by its model [4]. The main objective of simulation is to experiment with the model, the experimenter proposes various "improvements" simulation model (creating variants), and verify their impact on the modeled system. The results of these experiments are re-applicable to the real system to improve its properties. Simulation is a support tool that allows engineers to test the effects of its decisions on the simulation model. The big advantage of this approach is that it is possible to visualize the future behavior of the system and based on his knowledge to undertake the necessary interventions in the real system. In assessing the results of a simulation are aware of the fact that the results obtained are probabilistic simulation model of the simulator and it is accordingly necessary to further its utilisation in work.

2.1. The Proposal of the simulation Model

In the design process simulation model it is necessary to distinguish several phases of a work. Each stage has a lot in common with the general issue of the draft model of a quantitative nature. In the simulation approach, however, some specific questions.

The main construction phase of the simulation model [4] are as follows:

- definition and analysis of the problem and determining the objectives,
- data collection and processing,
- the design of the conceptual model,
- design simulation model,
- verification and validation model,
- carry out experiments and analysis of the results,
- implementation.

Applying these steps before construction of a simulation model of the project creates a presumption of success in modeling the project, while increasing the efficiency of the work and reduces the risk of stressful situations on the research team and also on the customer.

2.2. Possibilities of the process projects by dynamic simulation model

Utilization of simulation in the design of management and creating some certainty that the planned tasks can be in a period of time actually implemented, the animation course of the project can serve to explain and help predict the behavior more thoroughly verify the results of the process of projects. It is also revealing in this way risks making the project even before it takes place. The simulation model projects are actually "business test" on the computer where are verified various and numerous variants of the project proposed solutions.

The program system Project Management Forecast (PMF) allows the modular access for simulation of project processes. Projector prepare the particular processes of project and he/she connects them together into the final model of project. First he or she could analyze and optimize particular processes of final project and then the whole project.

Simulation model allows the simulation [4], [8]:

- variability of process parameters,
- cycles in the project processes,
- branching of the processes,
- optimization of project variants,
- risk analysis of simulated projects,
- economical ascents of project,
- empirical analysis of project variable sensibility,
- independently repetition of the project simulation.

Usage of the options before proposing a model project provides a dynamic process modeling project, due to be held comprehensive project evaluation process, but mainly to capture complex linkages of process, comprehensively monitor their dynamic and stochastic properties, including economic factors and thus capture the impact of individual processes the evaluation indicators of innovative design project.

2.3. Quantified outputs of the dynamic models

PMF execute many things instead of users. It comes about calculations of valuating economical (financial) indexes. If in any block of simulation model is realized issue it updates behind the scene too and it means the change of [4]:

- value of cumulative costs,
- value of cumulative cash – flow,

- discount value of cumulative discount costs,
- discount value of cumulative discount cash – flow.
- discount value of cumulative discount cash – flow.

Analogical, if in any block of program is realized the receipt (earnings) it updates behind the scene too and it means the change of [4]:

- value of cumulative receipt,
- value of cumulative cash – flow,
- discount value of cumulative discount receipt,
- discount value of cumulative discount cash – flow.

These are automatically reached economical indexes from simulation model of the project, which are very important for decisions. It is group of economical indexes, which are sufficient in many cases for basic decisions about effectiveness of the project. The PMF user doesn´t need to programme it, they are creating automatically after the application of command out and into in simulation model.

When the user need for decision indifferent additional economic indexes, there is possibility to fill up into the model namely like with scheduling of additional relation or progress.

It´s important to warm, that for automatically creating economical indexes of model and additional schedule indexes are automatically created on output from program graphs and histograms. These are provide important information for decisions.

Part of the PMF program is also empirical analysis module dependence, which allows the user to watch a graphical dependence of one variable on another. PMF does not evaluate within that module dependence of one variable to another variable, but only displays the graphic and the assessment remains the user.

This module allows for one main variable the graphical illustrate of six depended variables. Values of main variable are on X axis and the values of depended variable are on Y axis. Six variants of these permutations give quite well plastic survey about what can happen. Thank to these it is possible to compare the dimensions of result changes of valuation indexes, for example: risk factor and recognize so-called fault value or more precisely resistibility toward the exist risk. This fault value is maximal possible change of risk factors for effectiveness sustainability of the project.

For an illustration in a pic. 1 shows the net present value NPV of variables: cost, cash flow and $ GAIN (cumulative sales value).

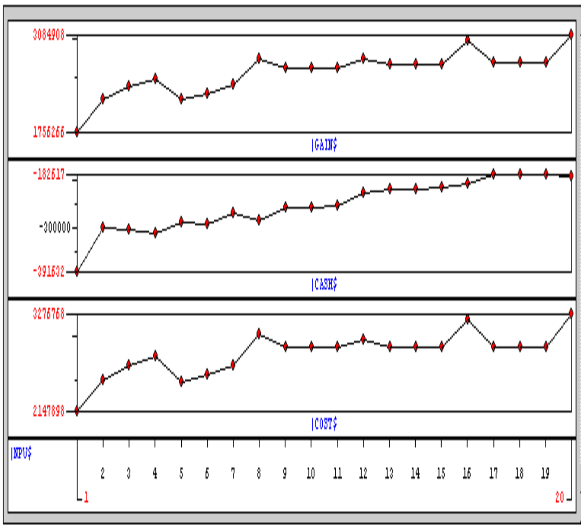

Fig. 1. Empirical analysis of the dependencies

3. CONCLUSION

Any high quality draft innovation project is necessary to be checked by dynamic modeling, with sufficient predictive capability to enable its efficiency through the optimization of alternative process of projects, analysis of risk of the empirical economic output and sensitivity analysis. This is based on the the fact that any innovative proposal, a number of risk factors that might in the future may adversely affect the entire project. It is therefore necessary that before the actual implementation of the project carefully consider all possible risks, including of their impact on the resulting efficiency of the project. Applications of the dynamic models for selected projects confirm their validity in the choice of design. Achieved values of economic indicators of the subsequent application of proposals in practice proved the credibility of dynamic models. It will therefore be necessary to pay more attention in the future promotion and implement dynamic models for the verification and evaluation of proposals for innovative projects, as is now used only a little.

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Tools of support and decision-making on development of industrial sector of economy

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Abstract

The aim of the research is to develop applied instruments which promote to make decisions in the field of analysis, forecasting and estimations of economic growth. Those tools provide the efficient directions of the development of the economic system in condition of the activations investment processes in industrial sector of the economy. Economic and mathematical methods, simulation and dynamic modeling were used for the research. For the practice use, all management decisions are offered in the field of financing a priority investment projects which are directed to develop the industrial sector of the regional economy.

Keywords: Investment; Econometric model; Simulation and dynamic modeling; Economic growth.

1. INTRODUCTION

Urgency of the subject studies is conditioned by significant need for development applied tools. These tools are designed to decision support in the analysis, forecasting and estimating trends in the development of effective economic system in terms of investment activity in the industrial economy.

Now limitation of access to stable investment sources doesn't promote the coordinated interaction of industrial and bank system that complicates investment development of economy. So in 2009 the share of the credit resources directed by banks, registered in region, in industrial sector makes only 26 % and a share of real sector in a gross national product - 66,5 %.

By researches it is established that recently banks prefer crediting of physical persons in a damage of development of industrial sector of economy.

The disbalance of relations of banks and the enterprises doesn't promote investment development of industrial sector of economy. The problem of management and optimization in investment process was considered by well-known Russian and foreign scientists [1,2]. Application of methods of simulation modeling, optimization in the economy is considered in work [4,5].

Attempts to solve the formulated problem, as reflected in the strategies of economic development, literature discussions, declaring financial instruments, but do not reveal the actual mechanism of the satisfaction investment needs of the industrial economy.

Creation and application of economic and mathematical tools in investment management processes to solve problems, can objectively evaluate the situation, both from the standpoint of the investor, and from a position of industrial sector.

2. TECHNOLOGY OF MODELING OF INVESTMENT DEVELOPMENT OF ECONOMY

The theoretical basis of the proposed tools is formulated by the principle of coordinated management of development in economic system. The principle assumes that at the expense of management of mutual development of bank sphere and industrial sector of economy gross national product (GNP) growth can be provided. It proves a source of economic growth. Interest of banks in investment activity is defined by expansion of economic space of bank sector as a result of growth of investment requirements of industrial sector of economy.

Modeling of process of the coordinated development is offered to be carried out in two stages. At the first stage the estimation of investment requirements of industrial sector is carried out on the basis of B. Hickman's investment function [3]:

$$K_i^* = \alpha_1 \cdot (Y_i^*)^{\alpha_2} \cdot (r_t)^{\alpha_3} \cdot \exp(\alpha_4 t), \qquad (1)$$

K - fixed capital; Y- GNP; r- interest rate; α1, α2, α3, α4 – equation parameters; t – modeling period.

This function it is possessed by good prognostic properties at adjustment for the statistical data.

At the second stage for an estimation of efficiency of use of investment resources in the industry it is possible to accept production function:

$$Y_i(I_i) = A(K_i + I_i)^{\omega} \cdot L_i^{\beta} \cdot e^{\gamma t} \qquad (2)$$

I- investments; L- amount of labour involved; ω, β, γ - equation parameters.

The model (2) is intended to determine motivated volumes of investment need and efficient management of investment reserves of the banks.

Support of decision-making of banks for choice investment directions is carried out on the basis of the designed simulation model and a management circuit diagram (fig.1).

The simulation model is designed on Systems Thinking software ITHINK and consists of three functional blocks corresponding to solved problems (fig. 2). In the first block there is an estimation of credit resources and the volume of investments which can be potentially directed to industrial sector of economy is defined.

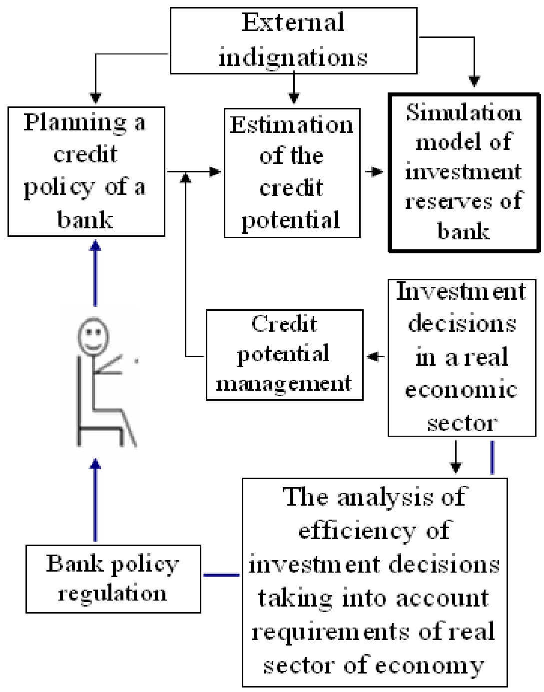
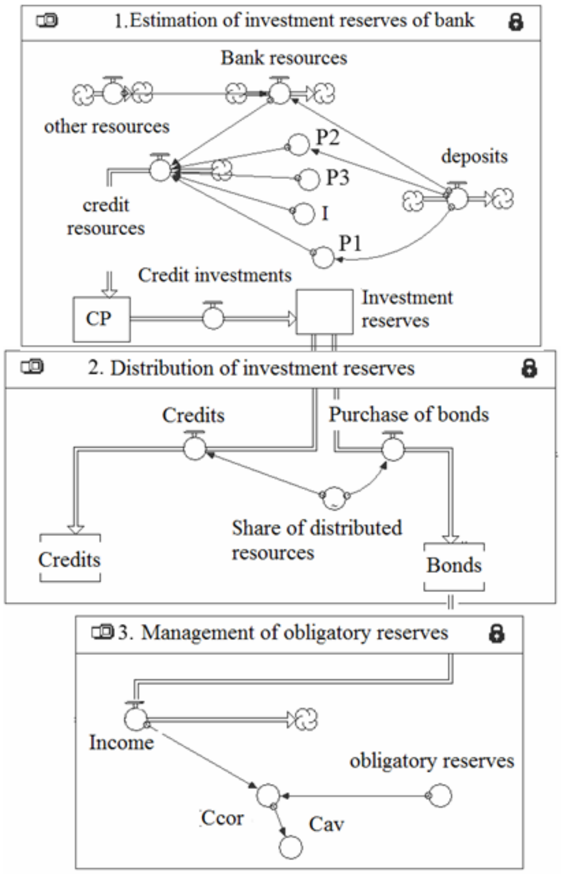


Fig. 1. Management diagram of credit resources

Financial resources is estimated for purchase of bonds of the enterprises of industrial sector in the second block. Essential possibilities on financing of industrial enterprises requirements are concentrated in bank sector.

The interrelation between obligatory reserves of banks and volume of the investment reserves directed to industrial sector is presented in the third block.

The model allows proving decisions on investment by optimization of obligatory reserves in a specific situation [3].



CP-credit potential; I- immobilization; P1,P2,P3 – bank specifications; Ccor – correction coefficient; Cav – averaging coefficient.

Fig. 2. Simulation model of investment reserves of bank

For banks the income of investment in bonds of the enterprises of industrial sector of economy develops of two components: percentage income and liberation of a part of obligatory reserves which can be used for specifications of bank activity. The offered regulatory mechanism of averaging banking reserves will be the tool of stimulation of processes of investment in industrial sector of economy.

The coordination of investment requirements of the enterprises of industrial sector with production potentialities of their effective realization is carried out with algorithm of decision-making on placing an investment resource in industrial sector of economy. The problem of modeling of variants of placing an investment resource, providing the maximum GNP is important. To solve the problem we use dynamic modeling based on a Bellman's optimality principle [4].

Dynamic modelling is successfully realized in an applied package of MathCad. Fixed capital should be increased by size of investment requirements or is corrected taking into account actually allocated volume of the investment.

Distribution of investments by economy branches can be considered as operated process.

The operated system is selected - the investment resources which are subject to distribution. Step-by-step managements - the resources, allocated to the enterprises of industrial sector are allocated.

Efficiency of placing of investment resources is defined on capital productivity ratio (C_{ef}) which characterizes size of return of investments in volume of GNP growth:

$$C_{ef\,i} = \frac{Y_i(I_{fact_i}) - Y_{f\,i}}{I_{fact_i}} \qquad (3)$$

$Y_i(I_{fact_i})$ - Volume of GNP with investments;

Y_{fi} – actual volume of GNP; I_{fact_i} - investments; i- economy branch.

3. RESEARCH RESULTS

Econometric model reflecting nonlinear character of communication of including factors is constructed for revealing of a tendency of the coordinated development of regional economy.

Selection of factors is carried out on degree of their influence on GNP (Y) taking into account a multicollinearity. As a result of the statistical analysis the model joins essential factors: 1) credits to the enterprises (x1); 2) budgetary investments (x2); 3) volume of foreign investments (x3); 4) insurance payments (x4):

$$Y = 363{,}82 \cdot x_1^{0,89} \cdot x_2^{-0,15} \cdot x_3^{-0,1} \cdot x_4^{-0,02} \qquad (4)$$

Model (4) admits significant by Fisher's criterion. It is shown that the leading part in formation of GNP is played by resources of bank system. But return of credit resources in gross national product formation low, so at increase in credit resources at one percent of gross national product increases only for 0,89 percent. For increase of return of credit resources in GNP it is necessary to stimulate not only credit, but also investment activity of banks in industrial sector of economy.

Result of imitating experiment is decrease in specifications of obligatory reservation on size corresponding to factor of averaging coefficient 0,79. It occurs at investment of 161688 thousand rbl. in the bond of the enterprises of industrial sector of economy.

Dynamic modelling was spent on the data on republic of Bashkortostan from 2002-2009. So the share of industrial sector in GNP will increase on 2,5 % if to direct investments on 1380 million rbl. to building and on 230 million rbl. - in extracting, processing branches, agriculture, electric power industry, transport and communication.

It is necessary to notice that the greatest volume of investments goes to a building industry of region. Investment support of a building industry is necessary, in a kind of the major role in the regional economy which is carrying out reproduction of fixed capital, development and improvement of social sphere, reconstruction, modernization of manufacture of material benefits. Thus, the maximum gain of GNP will make in 11694,87 million rbl.

4. CONCLUSIONS

Thus, distribution of investments between industry enterprises can appear effective at use of a complex of analytical tools on the basis of optimizing and econometric models. Adaptation of the offered toolkit to the changing statistical data will allow to raise adequacy of investigated tendencies of development of real sector and to increase accuracy of forecasting estimations.

Realization of the offered toolkit will promote acceptance of the well-founded and effective administrative decisions at all levels of economic system, and also will allow to model and predict development of real sector of economy.

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Control of the Financial Flows Formation in the Non-Balanced Conditions of Goods and Labor Markets

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Abstract

Cognitive and dynamic models of the macroeconomic system functioning in non-balanced conditions of goods and labor markets interaction are presented in the article. The article includes results of the experimental research of dynamics of interconnected changes in price level and wage rate in the system of macroeconomic financial flows turnover. The research is held by means of system analysis, control theory, theory of complex systems simulation, economics and mathematical methods, methods of artificial intelligence, methods of decision-support theory. The aim of the research is to increase control efficiency of the macroeconomic system functioning in non-balanced conditions of macroeconomic markets and to define influence of the markets on dynamics of income and expenses formation in sectors of economy in the system of the macroeconomic financial flows turnover.

Key words: Labor market; Wage rate; Macroeconomic turnover; Cognitive model; Dynamic model.

1. INTRODUCTION

To date the Russian economy is functioning in conditions of recession overcoming that is coursed by both international financial crisis and continued formation of the market control mechanisms. In this conditions the problem of increase of control efficiency of financial flows formation in the macroeconomic system functioning regarding control mechanisms of goods and labor markets is relevant.

The main interest refers to the research of non-balanced processes of formation of the income and expenses flows in sectors of the macroeconomic system regarding stocks and market control mechanisms and to the influence of the government control in the form of different policies, particularly fiscal and monetary policies [1, 2].

2. COGNITIVE MODEL OF THE MACROECONOMIC SYSTEM FUNCTIONING REGARING GOODS AND LABOR MARKETS

Cognitive model of the macroeconomic system includes four macroeconomic agents that represent sectors of economy which are real and financial sectors, households, government. The interaction between the agents in time is connected with the formation of the financial flows of different rates and directions. The flows are incomes and expenses of each agent. The model also includes information connections that characterize stocks of each agent and therefore the agents behavior is controlled on the basis of the information about the amount of the stocks [5].

Apart from the macroeconomic agents the cognitive model includes two macroeconomic markets: goods and labor markets. Macroeconomic markets included in the model, first, do not change the essence of the flows formation between the agents that provide the financial flows turnover; second, is not connected with the local mechanisms of information correction of the expenses formation rates of each agent on the basis of information about the amount of stocks; third, supply the information mechanisms with the mechanisms of financial flows control that are based on the analysis of the entire macroeconomic system state in the form of information about aggregate demand and supply, and about labor market state.

Simulation and analysis of the relationships of labor market functioning is held on the basis of Keynesian employment conception regarding contemporary labor markets theories [3].

Labor market functioning is regarded in dynamics; demand, supply and wage rate interaction is considered during time, and the research focuses on the non-balanced state of the labor market. The labor market is a macroeconomic market that aggregates microeconomic markets in order to define the most important connections rules of demand for labor, labor supply and wage rate.

Demand for labor is the amount of employees that can be employed to produce gross domestic product at each possible wage rate all other conditions being equal. Demand for labor is the function of the real wage rate, non-price determinants and time. Non-price determinants are changes of aggregate demand, labor productivity, and resources price. Demand for labor is by nature a stock. Demand for labor is determined by marginal labor product and according to Keynesian concept is the derivative from the aggregate demand for goods and services. Labor supply is the amount of employees that wish to participate in gross domestic product formation at each possible wage rate all other conditions being equal [4]. Labor supply is the function of the real wage rate, set of non-price determinants and time. Non-price determinants include price level and money illusions connected with the valuation of the price level influence on the real wage rate. Labor supply is by nature a stock.

Macroeconomic markets can be both in balanced and non-balanced states. Balanced state is characterized by the equity of demand and supply. Such states are idealized but are used in the research of the behavior trends at the set of non-balanced states. Such macroeconomic markets as goods and money markets are characterized by the self-regulation of demand and supply. Thus, goods market in non-balanced conditions according to the self-regulation mechanism balances aggregate demand and supply as material flow rate and financial flow rate due to the regulation influence of the price level. The feature of the labor market according to Keynes [3, 4] is absence of the self-regulation mechanism. Labor market does not possess the mechanism to balance demand for labor and labor supply. Therefore labor market is characterized by the state of stable non-balance. In practice generally labor supply exceeds demand for labor $Ns > Nd$, where Ns – the amount of economically active population, and Nd – the amount of employees. The difference between mentioned values percentage expressed in relation to the amount of economically active population determines unemployment rate [4].

From the set of non-balanced states of labor market the state of full employment is supposed. The state is characterized by the unemployment being equal to the natural level. The natural unemployment includes frictional unemployment connected with the time delay of the objective processes of the job and employees search; and structural unemployment caused by the discrepancy between the demand for labor and labor supply structures. The natural unemployment level is important from the macroeconomic control view. It is considered that decision making to decrease unemployment level on labor market in conditions of natural unemployment is not essential. It is explained by the fact that natural unemployment is considered as a labor reserve that is essential for the economics to provide flexibility in solving different problems.

From the set of non-balanced states in the area of underemployment the only state is chosen. The state is defined as the basic balanced state and is characterized by the macroeconomic system functioning in conditions of balanced goods market and quasi-equilibrium on labor market. In the situation the notion of effective demand is used. The notion was introduced by Keynes in order to define aggregate demand in conditions of aggregate demand and aggregate supply being equal [4].

The features of the dynamics of goods and labor markets interaction are the following. Goods market influences labor market and courses changes of the last. The changes are connected with demand for labor formation that depends on the effective demand on goods market. Besides, price level formed in goods market influences labor market. Price level is the information indicator on decrease of the real wage rate in conditions of inflexible nominal wage rate. The features of labor market reaction on the changed goods market state are lag and time delay in demand for labor change in case of aggregate demand change. Labor market forms the response to change of goods market state only in conditions of goods market convergence to a new balanced state that is a new value of effective demand. As a result of demand for labor and labor supply the amount of employed and unemployed are determined. The influence of labor market on goods market is directed to the adjustment of the production plans about gross domestic product formation on the basis of information about the change of wage rate that characterize future expenses. The influence of labor market on households is to change disposable income and to change as a consequence households stocks under the influence of wage rate.

3. FUNCTIONAL DIAGRAMS OF THE DYNAMIC MODELS OF THE MACROECONOMIC SYSTEM FUNCTIONING IN CONDITIONS OF GOODS AND LABOR MARKETS

Composite functional diagram of the dynamic model of the macroeconomic system functioning regarding goods and labor markets includes six models that are connected by means of flow and information connections.

The models A1-A4 are to describe real sector, households, financial sector and government respectively. The detailed description of each sector and connections between them is presented in [5]. The A5 model describes goods market functioning and is presented by two blocks. The blocks are aimed to reflect dynamic price level formation on the basis of the information about aggregate demand and aggregate supply [5].

The A6 model describes labor market functioning and is aimed on, first, demand for labor formation on the basis of the information about the marginal labor productivity; second, labor supply formation on the basis of the information about the amount of economically active population and nominal wage rate that corresponds to the basic balanced mode. Natural rate of unemployment defines the excess of the current unemployment level above the natural. In order to correct the financial flow of labor costs that is formed in the process of gross domestic product distribution the correction coefficient is calculated according to the changing wage rate.

Functional diagram of the dynamic model A6 describes labor market functioning and includes six dynamic subsystems that are connected by means of information connections. A61 model shows the mechanism of formation of the inclined part of the demand for labor plot. A62 model is to define effective employment that is required to form the demand for labor limit (the vertical part of the demand for labor plot. A63 model forms labor supply and a current wage rate. The plot is the basis for A64 model to form the entire demand for labor dependence and to define the unemployment level regarding the current labor supply and wage rate. A65 model is to calculate the coefficient of the remuneration rate. A66 model defines the current unemployment level regarding the natural rate of unemployment.

The suggested model are the basis for the experimental research of the influence of the non-balanced conditions of labor market on the dynamics of the macroeconomic financial flows turnover in the macroeconomic system. The experimental research is held by means of the scenario approach. The results of the experimental research of the control efficiency of the macroeconomic system functioning in market conditions show that the decisions made provide the transfer from negative dynamically non-balanced market states to positive states. The last are characterized by the former or new gross domestic product rate.

The scenarios researched showed the possibility of the effective control of the macroeconomic system functioning in market conditions in case of fiscal and monetary policies being used as a part of the government control of the macroeconomic system. The experimental research showed the importance of the accuracy and the appropriate sequence of the decision made. It contributes to achievement of the higher gross domestic product rates for the entire macroeconomic system.

4. CONCLUSION

Cognitive and dynamic models presented are to define the influence of the information control mechanisms of labor market in the process of the macroeconomic system functioning. The feature of labor market functioning is the absence of the self-regulation mechanism that leads to the state of quasi-equilibrium on the market.

The features of the labor and goods markets interaction, labor market influence on the real sector and households are presented. The experimental research is held by means of scenario approach and showed the control efficiency of the macroeconomic system functioning in non-balanced conditions of goods and labor markets interaction.

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