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Quality Estimation of the Boiler Steel 13CrMo4-5 by the Metallographic Replica Method

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Abstract

During the projected lifespan, most components of the boiler are exposed to increased values of temperature and pressure, flue gasses and variable loads, which are causing significant changes in the structure of the material. Since we live in a time when survival is almost impossible without electricity, halting of the entire power plant in order of taking samples for examination represents enormous expense. Application of metallographic replicas as a method of non-destructive examination of the structure represents a practical and reliable way of detections changes in the layer under the surface, as well as changes in structure caused by work on elevated temperatures. This method can be used for examination of entire constructions, as well as finished products from the industry. In the experimental part of the work, quality estimation of material used for manufacturing of boiler the headers made of low - alloyed steel 13CrMo4-5 was performed. The aim of the test is a determination of workability of tested components, as well as evaluation of the possibilities for further course of exploitation.

Keywords: steel 13CrMo4-5, metallographic replica, quality, structure changes

1. INTRODUCTION

Due to good mechanical properties, chemical stability and gas corrosion resistance at elevated work temperatures, application of low alloy boiler steels such as 13CrMo4-5 are widely spread in the manufacturing of pressure parts for the purpose of a thermal power plant. This type of steel is especially used in thick – section components such as steam pipes, steam collectors and the headers. Particularly, these are tubing steels for the cooler section of reheaters and superheaters, membrane walls etc. [1,2]

The relative low content of carbon in structure (C_{ekv}<0.25) also benefits the application of this steel type, due to its very good weldability.

Cr and Mo in the structure are forming special carbides (Mo_2C and Cr_7C_3) which are slowing down creep and rising hardenability, while Mo is preventing embrittlement failure. Temperature range of application of above - mentioned steel is 450-580°C: on higher working temperatures carbides are coagulating, the ferrous matrix is depleting with Mo, which results with a lower temperature of recrystallization. The microstructure of low alloy steels is ferritic – perlite structure (in case of conducted normalization) or bainitic. [2]

One of the significant representatives of low alloy boiler steels is 13CrMo4-5, whose chemical composition is shown in Table 1.

Table 1. Chemical composition of 13CrMo4 steel [3]

Content of chemical elements in base material, [%]							
C	Si	Mn	Cu	Cr	Ni	Mo	Al
0.140	0.25	0.52	0.15	0.93	0.150	0.47	0.02

Above mentioned steels are seamless hot rolled tubes, normalized at 900°C, slowly cooled on still air, hardened at 730°C and cooled on air.

2. PROBLEM DESCRIPT

During the routine examination after welding, a large amount of linear indications has been noticed in weld zone the header – connection. In spite of fact that inspection certificate for the material of the headers was valid, a base material of all the headers from the same batch (219,1 x 40 x 2 170 mm) was examined with MT testing.

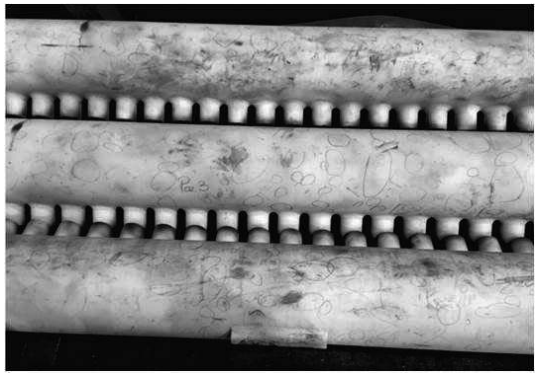

Fig. 1. MT examination of 13CrMo4-5 the headers

Fig. 2. MT examination of 13CrMo4-5 the headers

Conducted MT examination of a base material of the headers outside of welding zone has also shown a large amount of indications, but according to standard EN 1369:2014, criteria of acceptability for linear indications were satisfied.

Later, indications were tried to remove with grinding, but without success: indications were still present on the the surface of the material and it was decided to withdraw them from the manufacturing.

3. METALLOGRAPHIC REPLICA

Storage tanks, pressure vessels, pipework, valves, and various safety critical components are designed that during the lifespan encompass gasses, liquids and solids on a way that loss of containment does not happen. Leakage of above - mentioned items of equipment may ultimately result with the major accident on site or in the workshop. [4,5]

The presence of hidden flaws (defects), corrosion or cracks in the structure of these components can result in the integrity of such systems being compromised and increase the likelihood of failure. Application of non - destructive testing (NDT) as a measure of discovering and identification of irregularities in the structure of the material is widely spread in practice. Often, only with the application of some od NDT methods current state of process plant can be obtained. [4]

During the lifespan, many machine elements and parts of construction are subjected to change of structure caused by high values of pressure and temperatures. Even with various available NDT, it's not always easy to monitor the changes in structure. The metallographic replica has proven to be very appropriate and reliable method of non-destructive examination of structure from almost any construction, no matter flat or curved the surface was. [1]

In thermal power plants where many parts of construction are exposed to elevated values of pressure, temperatures and aggressive flue

gasses, shutting the whole plant just for taking the specimens represent enormously costs.

Possibilities of application of metallographic replica for examination of the surface and subsurface structure changes are wide, but the application of this method is very interesting for thermal power plants and nuclear plants.

4. EXPERIMENTAL SETUP

I order to find out possible reasons of the appearance of indications on the the surface of the the header, first, it was necessary to examine the the microstructure of selected the header with field test method by taking the print of structure – replica.

Examination of the the surface with the metallographic replica is carried out ISO 3057: 1999 (ISO 3057: 1998).

From the the header 2 170 mm length it was taken the section in length of 255 mm by saw with intense water cooling during the entire cutting process (Fig. 3).

Fig. 3. The specimen for metallographic replica

Preparation of the specimens from steel and steel alloys consists of grinding, polishing and etching the surface of the specimen with the adequate chemical solution. [2]

On the fig. 4 is shown grinding of place where replica number 2. With the grinding most of the impurities such as corrosion, dust etc. are removed from the surface of the metal.

Next step after grinding is polishing, and after polishing is performed, the specimen is etched in the chemical solution (nital, for this type of steel). The surface of the specimen after fully performed preparation is shown at fig.5.

Fig. 4. The principle of applying the replicas

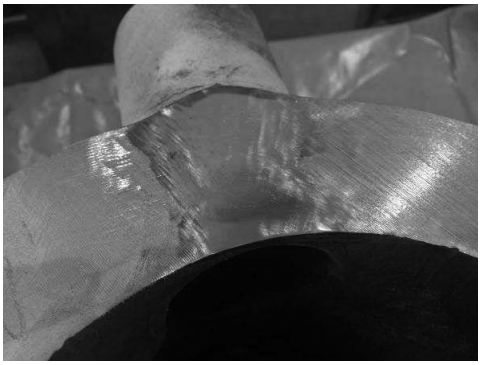

Fig. 5. The surface of the header prepared for taking the replica

On the fig. 6 is shown a selection of positions for taking metallographic replicas for the examined the header. The first replica is taken on the place where the header and nozzle are connected (welded). Replica number 2 is taken from the side of the header where the is noticed damage of the surface.

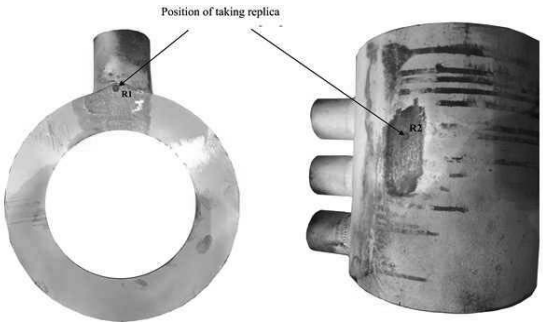

Fig. 6. Defining the position of taking the metallographic replica

After preparation of the surface is performed, next step is preparation replica foils. Replica foils need to soften in solvents like acetone or methyl - ethyl acetone, then inserted on the surface of material and evenly pressed (fig. 7). [2]

Fig. 7 Metallographic replica number 1

On fig. 8 is represented applied replicant foils (manufacturer Struers – Transcopy) for the examination of the microstructure of the header (13CrMo4 - 5) in experimental part of paper. Replicant foils are plastic foils covered with a thin layer of metal for reproduction of the surface and the subsurface of the replica.

Fig. 8. Principle of applying the replicas

Layer of metal on the surface of foil provides effective reflection of light while testing the replica with an optical microscope, and allows safer and easier handling of the replica during the further examination of structure. [2]

5. EVALUATION OF RESULTS

The test results in the form of structure images of the examined material are shown in fig. 9 – 11. In the initial state, the structure of 13CrMo4 - 5 is a mixture of ferrite and pearlite, while in pearlite areas colonies occur where cementite lamellas are parallel to one another. [2] Within a single pearlite area, these colonies are arranged at different angles in relation to one another. The example of the characteristic structure of 13CrMo4-5 steel in initial state is shown in Fig. 9.

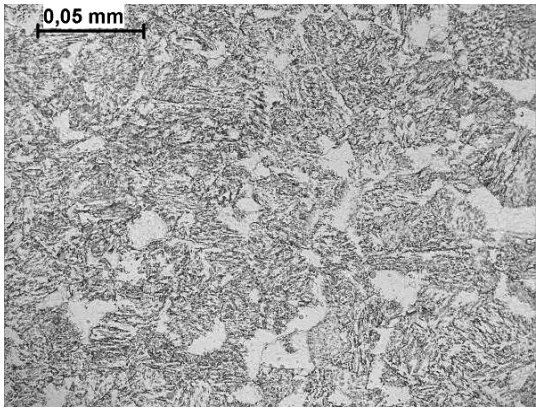

Fig. 9. The microstructure of base material of the header in initial state

The example of characteristic structure of 13CrMo4-5 steel in heat affected zone of replica 1 is shown at fig.10.

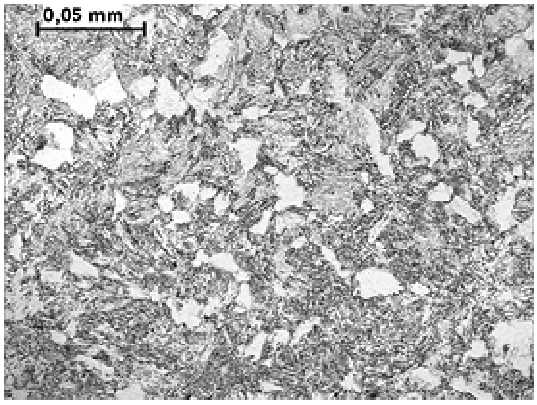

Fig. 10. The microstructure of heat affected zone of replica 1

In the heat affected zone, under the influence of heat inserted with welding the grain has occurred. The growth of the grain size can be taken as one of the major mechanism of degradation in process of welding, especially when large amount of heat was inputted.

Also, value of hardness will be greater in heat affected zone than in base material: this change will depend on the amount of heat input

and the cooling rate. During the process of heating, a complete transformation of the ferritic – pearlitic the microstructure of the base material occurs into the austenitic structure. Due to the high temperatures in this part of welded joint and cooling with great speeds, austenite is transforming into bainite with Widmanstätens structure on the grain boundary.

The example of structure from the side of the header where damage on the surface of material is noticed at fig.11. Structure observed on fig. 11 is similar to structure of base material of the header – pearlite.

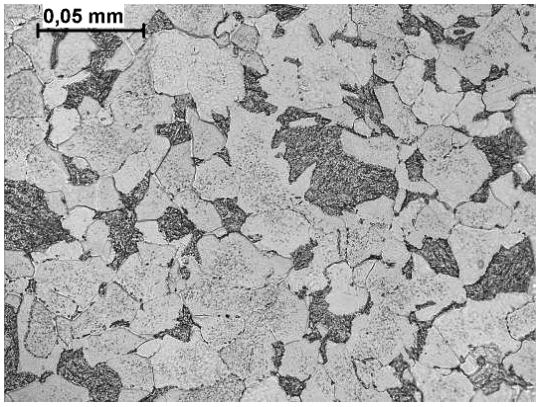

Fig. 11. The microstructure of material of replica 2

6. CONCLUSIONS

The aim of this paper is the microstructure examination of the headers made from 13CrMo4-5 low alloyed steel with metallographic replica.

Based on large number of linear indicions in weld zone of the header – nozzle, joint, it was decided to examine base material outside the welding zone for all the headers with same dimensions (219,1 x 40 x 2 170 mm) from the same batch of material.

Based on conducted examination of the microstructure with metallographic replica (and later mechanical properties), it can be concluded that, regardless to indications on the surface of material, after grinding and then closer examination with some volumetric method of NDT (such as radiography) examined material can be used for original purpose (bottom the header of front wall in boiler power plant).

Indications on the surface of the headers are most likely defects occurred during the hot rolling process. Also, during the entry control of material grinding traces are spotted at the the surface of material, and it was assumed that there might be visible to the bare eye (removed by manufacturer).

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Model Development for the Control of Warehouse Operations with the usage of RFID

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Abstract

Supply chain efficiency greatly depends on effective support from the available warehouses. Customer habits are a changing category and with the expansion of online ordering, their requirements are targeted towards fast delivery times with no errors and with minimal costs. In comparison with the manually operated warehouse, an automated warehouse offers better fulfilment of the given requirements with less errors and higher reliability. Warehouse control system plays an important role in the everyday management of automated warehouse operations. The control system manages the requirements for goods identification and picking, its transportation inside the warehouse; it also enables the monitoring of the goods manipulation equipment and provides statistical data necessary for the decision making. This paper presents the analysis of requirements and the development of a model for the control and automation of experimental logistics warehouse (developed for the educational and research purposes) with the usage of RFID. The model would further serve as a basis the control system development for enabling the supervision of warehouse operations and the equipment. The paper also presents the analysis of trends in the logistical goods manipulation like application of Internet of Things and Cyber-Physical Systems. Following the trends analysis, the recommendations for the further development of warehouse operations management system are given.

Keywords: warehouse control, automation, model, RFID

1. INTRODUCTION

The role of the warehouses in the supply chain is very important since their performances often influence how quickly the ordered product is shipped to the final customer. Since the todays buyers tend to completely move towards online shopping, the efficient supply chain demands the fast and reliable execution of the warehouse operations. Warehouse processes complexity is growing with the development and growth of production and service systems. The time demanded for an item to be stored or retrieved from storage location is getting shorter. Most common warehouse operations include goods receipt from transport vehicle, transportation of received goods to storage location and the storage itself, picking the ordered goods from its storage locations, grouping goods from various customer orders by destination and loading the picked goods to transport vehicles [1]. In this process the items can be hard to track and they can be easily misplaced, which leads to the increased warehouse costs and late deliveries to the customers. For the purpose of dealing with these problems, the Radio Frequency IDentification (RFID) technology is applied along with the appropriate software better known as the warehouse management system (WMS).

To further investigate the application of these technologies, this section presents the literature review on RFID technology and its application in the warehouse operations and in the supply chain. Also, the review on new approaches in logistics goods manipulation like Cyber-physical systems

(CPS) and Internet of Things (IoT) is given. Second section of this paper represents the methods and materials used for the research, followed by the case study presented in the third section. The third section also presents the developed model for warehouse control. Fourth section represents conclusions and further research directions.

1.1 RFID technology and its application in managing the warehouse operations

RFID represents the technology with the function of objects identification presuming that an object has an attached tag (transponder) with the information which can be read by the reader [2]. The information stored on the tag can be item ID, location, name of the item, company name etc. Tags and readers can be active and passive. Active RFID tag has a battery which enables information sending in certain time spans. Passive RFID tag only emits information when it receives a signal from a reader. Readers can also be passive (only receives information from tag) or active (can emit and receive information). Distance is also important when RFID technology is used. If RFID technology enables only small reading distance then it is called near field, and if the reading distance is larger (several meters for instance) then it is called far field RFID [2].

The application of RFID technology in the warehouse enables item identification and improved data accuracy [3], automation and real-time locating and tracking of stored items [4], optimization of everyday work operations [5], and inventory information sharing between different actors in the supply chain [6].

In [7], a warehouse management system backed up with the RFID technology is described. Presented system contains the RFID reader at the warehouse entrance which is used for the incoming and outgoing items identification. Items are packed into boxes and transported to the storage location which is also equipped with the RFID reader which automatically reads the item data and transmits it to the warehouse management system database. Tagged items are stored randomly at any free location. When the item is needed the same reader is used to activate the pushing device to put the wanted item on an output container.

Another example of RFID enabled warehouse management system is presented in [4]. In the warehouse, similar items are packed into pallets which are then put into available storage locations. The control system presented consists of three parts. First part is the warehouse management system, second is the guided system for forklifts and the third part is the warehouse database and the storage rules database. Warehouse management system enables visual representation of the storage space and helps in inventory management. Warehouse management system links the data about the pallet and the storage location using the ID fields on RFID tags (which exists both on pallet and storage location), and generates the storage locations map. The forklift guided system receives the commands from the management system and helps the drivers to locate the pallets at storage locations via map. The third part of the system enables responsiveness to the events which carry out in the operational environment.

In [5] the RFID technology is used for the warehouse resource management. System comprises of two modules. First module is used to collect data from passive RFID tags placed on the pallets and items, and data from active RFID tags which are placed on moveable warehouse resources like forklifts. For passive tags the readers have integrated antennas to collect data within their range. For active tags the ultra-wide band technology is used to track resource location within the warehouse. Second module enables the resource tracking and resource management. Resource tracking is realized through the server which stores previously collected data and calculates the resource positions. Resource management uses data from resource tracking to optimize resource usage and allocation. The second module is also backed up with the data warehouse which manages all internal data and the data from company's suppliers and buyers.

The RFID system presented in [8] provides better visibility of warehouse operations and increase in productivity. System is composed of three tiers. First one represents the data collection via RFID devices in order to accurately show the current status of the work operations. It is possible to track location data, quantities data, and operations status data. Second tier is the database management system used for storage of collected RFID data and for providing the data via SQL queries. The third tier provides meaningful means of retrieved RFID data from the database. It enables equipment selection for the material handling, the determination of the location of warehouse resources and the optimized routing for stored unit retrieval.

1.2 Adopting the RFID in the warehouses of the supply chain

In [9] it is presented how the RFID technology is deployed in the warehouses for the humanitarian supply chain in India in order to prevent inventory inaccuracies, shrinkage and misplacement. The supply chain includes procurement agency and shops with several warehouses on the government and state levels between. Warehouse operations include packet receipt, putting away the packets, picking of the packets and dispatching. The packets are tagged at the procurement agency and then distributed from one warehouse to another. Every warehouse has RFID antenna positioned at the warehouse gates and also in every warehouse the handheld RFID readers are used for tracking the packets. This way the humanitarian packets can be tracked through the whole supply chain.

As presented in [10], the supply chain processes for spare parts are redesigned with the use of RFID technology. The presented supply chain consists of headquarters, central distribution center, local distribution centers and several hundred repair shops. Participants in the supply chain possess the information system which helps them in doing everyday operations for inventory replenishment. The main problems to solve are the large number of manual operations in the warehouses causing the long waiting times, and the inventory information inaccuracy in the information system. RFID technology is implemented in the warehouses of distribution centers where the readers are put at entry and exit gates, and can collect data from tagged pallets in real time and send it to the information system. This has enabled elimination of some manual operations, improved information accuracy and visibility of the incoming and outgoing warehouse items.

1.3 Application of new technologies in combination with the RFID

Further development trends in the warehouse management consider greater integration of RFID technology and warehouse management systems with other elements of supply chain [11]. As all supply chain participants tend to integrate, with improved communication between transportation and the warehouse, the operations can be better planned and executed. Application of concepts like Cyber-physical systems and Internet of Things will increase the transparency levels of goods flow in the supply chain, enable automation of logistic operations such as goods loading, picking and inventory checking, with restricting the human role to supervisory one [12]. The transportation and storage units will change and adapt for the integration into IoT. The example of this is presented in [13] where the intelligent bin is developed in way that it contains sensors, micro-processors and solar cells to autonomously communicate with the logistic environment and be energetically independent. Also, with more emphasis put on the customized products produced in a mass production environment, the role of RFID is seen as crucial in enabling real time information about the movement of product items [14].

2. METHODS AND MATERIALS USED FOR RESEARCH

The scope of the research is the application of RFID technology in the experimental warehouse and its integration with the warehouse management system. Based on the analysis of the related solutions and approaches to similar

problems reported in the literature, the model of the RFID control system is made and explained.

3. RESULTS AND ACHIEVEMENTS

The experimental logistics warehouse (developed for the educational and research purposes) consists of two isles which are marked with letters A and B (Figure 1). Isle A is used strictly for pallet storing (Figure 2) and comprises of 18 pallet locations. The pallet contents are not changed.

Fig. 1. Experimental warehouse

For the pallet manipulation the forklift is used. Isle B is used for storing the pallets which contents can be changed (Figure 3). There are 12 pallet locations on isle B, where every pallet has a capacity of 36 boxes in which the product items reside. For box manipulation the vertical crane is used (Figure 3).

By analyzing other examples reported in the literature, the RFID technology cannot stand for itself in the warehouse. Besides it, the warehouse management system (WMS) is needed, since it contains the logic behind the item manipulation. The control system should have connection to the supply chain management system (SCM software).

The proposed model of the control system is presented in Figure 4. We propose a solution which is based on the RFID data collection with tagging the pallets on isle A (18 tags) and tagging the pallets (12 tags) and boxes (432 tags) on the isle B. The products in the isle B which are put in the boxes should be barcoded. RFID readers can be used as handheld devices by operators and also are to be put on the resources used for item manipulation and at the warehouse doors and at the loading/unloading point. All tags are passive.

Fig. 2. Warehouse isle A

Tag memory should be enough to support the keeping the data about pallet ID, barcode IDs of the items stored on the pallet, time of storage, storage location. The created data is to be transfered to warehouse management system.

The warehouse management system is the second part of the control system which will enable the inventory management, warehouse operations management, resource management and reporting.

Inventory management is the functionality which provides information about what is stored, when it is stored and where it is stored. This functionality is to be realised with SQL queries which can provide such information.

Warehouse operations management functionality refers to the management of items reception, putting and storage of the items, their

picking and dispatching. The first step is to unload the products from the transportation, barcode them and pack them on the tagged pallet (isle A) or pack them into the tagged box and then on the tagged pallet (isle B). Each item's barcode is scanned prior to packing and entered automatically into PC which sends the data to the RFID writter (writting the data to RFID tag) and to WMS database. Next step is to retrieve the free storage location from the WMS and to transport the pallet. Storage location status is updated and the products are stored. Basically, the system should enable connecting the pallet with its content and also connecting a pallet with the storage location. This implies that the storage locations should also have RFID tag for the purpose of tracking the state of the location (free or occupied) and the contents.

Resource management is to be realised with the controling of the vertical crane for retrieving the boxes and with informing the forklift operator from which location the pallet should be taken. Both resources need to be equiped with the RFID readers which can collect the information about the retrieved items, which is to be sent to a WMS in order of updating the inventory database information.

Reporting functionality enables the periodical reports concerning the warehouse operational and resource efficiency.

Fig. 3. Warehouse isle B

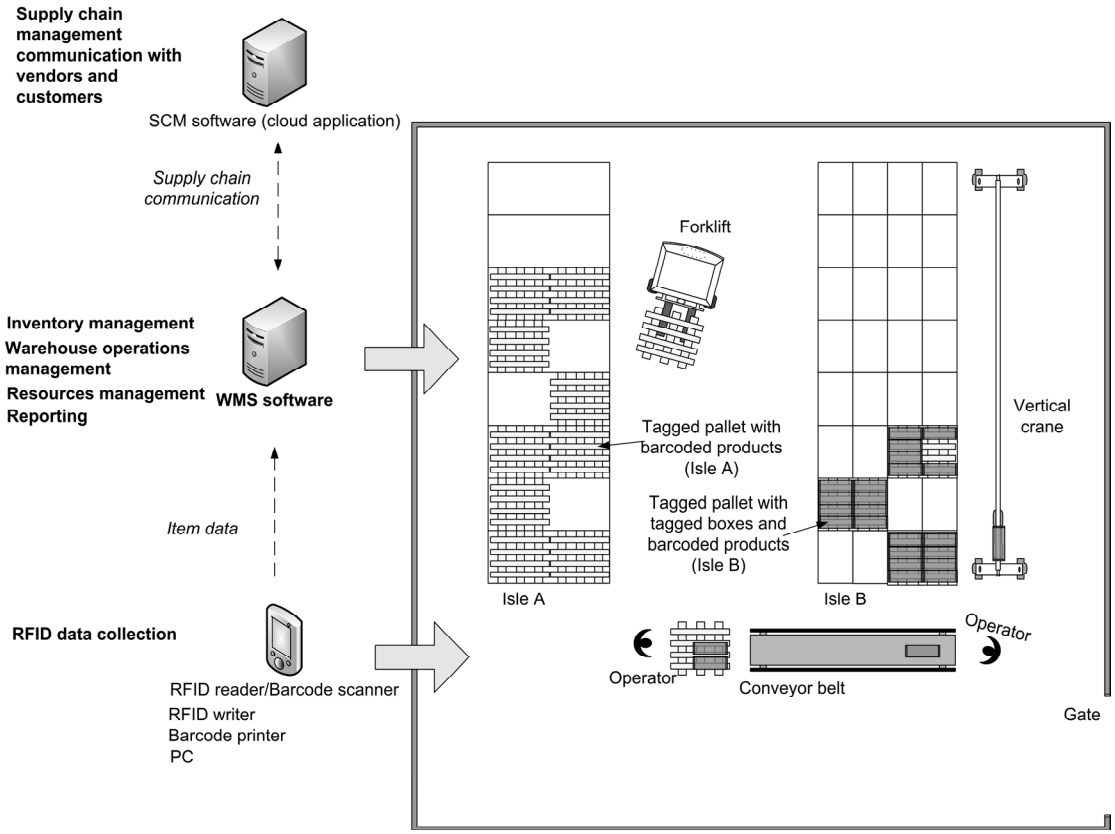

Fig. 4. Model for the control of warehouse operations with the use of RFID

4. CONCLUSIONS

The research in this paper presented a model for the control of the warehouse with the use o RFID technology. The model was created by analyzing the developed systems applied in other warehouses. The next step is to test the proposed solution under various conditions with varying demand and resource availability, and to analyze the system performance. After the system is confirmed by tests its implementation is to start. Also, other concepts should be further explored like the implementation possibilities of smart item storage units (similarly like presented in [13]) and the possibilities of autonomous resource communication with WMS.

5. ACKNOWLEDGEMENTS

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Experimental Determination of the Beam Buckling Load

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Abstract

Two ways of a beam buckling load determination are discussed in this contribution. When performing the buckling experiments, the steel tubes with six different lengths and two diameters were used. Except the axial load, a lateral and axial displacement were measured. The buckling load was determined as a maximum tangent value from the load – displacement curve, where both axial and lateral displacement were used. The relation between the axial and lateral displacement was derived analytically and the results were compared with those obtained from the experiment. Moreover, the maximum load was measured for a comparison. The effect of both approaches for the buckling load determination is presented and their interchangeability in the range of our experiments is proved.

Keywords: Beam Buckling; Buckling Determination; Experimental Buckling Load.

1. INTRODUCTION

Space trusses have been widely used in engineering structures. They are mainly composed of long steel members loaded by an axial force. Therefore, a buckling occurs there. The determination of the buckling load is essential to access the reliability and safety of space truss structures.

Several authors have discussed the buckling load as a maximum measured force of the buckling test (the LM approach in our text). Likewise, the asymptotic method is mostly used which determine the buckling load on the basis of a load – displacement curve. Shariati et al. [1] used the load – lateral displacement curve for take a peak value to determine the buckling load.

The "Top of the Knee" method was described in the book of Jones [2] and in the report of Nishino, Ueda and Tall [3]. The procedure of the buckling load determination is based on the load – displacement curve.

Turkmen [4] applied the Southwell plot for the buckling load evaluation. At this approach, a linear slope created from the load and lateral displacement is a base for the buckling computation. Bedon and Amadio [5] used this method for their research of flexural-torsional buckling of rectangular laminated glass beams. Borowitz and Bank [6] used this approach for a web buckling determination.

As a base for the buckling determination, Ziółkowski and Imiełowski [7] compared the load – axial displacement curve and the load – lateral displacement curve. They mentioned that the first one provides clear information on the energy aspects of the buckling. On the other hand, the second one is very good for the buckling event detection. Ye, Hajirasouliha and Becque [8] compared both mentioned ways for their research of cold-formed steel column buckling and brought the same conclusions.

Dundu [9] created the load – axial displacement curve for his research of short cold-formed lipped channels. Because the curve

raised linearly until the maximum loads, these values were taken from the graph as the buckling loads.

Considering the maximum measured force as the buckling load, there is no needed to measure deformation neither axial nor lateral. In case of elastic models, there is a question, whether the maximum tangent load should be used which is analogical to the proportional limit. Another question is, whether the axial or lateral displacement should be used for the load – displacement curve. In this contribution, both approaches will be compared and discrepancies will be evaluated.

2. THEORETICAL BACKGROUND

When considering the load status of a beam during the buckling, a deflected line is investigated as shown in Fig. 1.

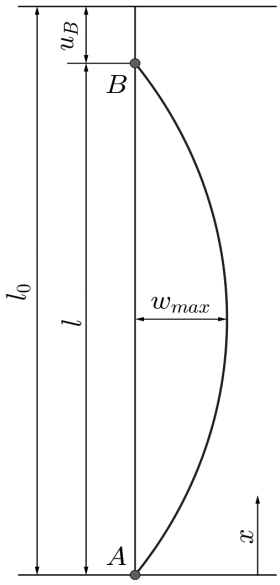

Fig. 1. Buckled Beam Line

Let the deflection line is in the form of sine function:

$$f(x) = w_{\max} \sin \frac{\pi}{l} x \qquad (1)$$

where w_{max} is the maximum lateral displacement of the beam with the length l_0. After deflection, the beam takes a new shape with the length l. The beam length l_0 is also an arc length of a neutral axis.

Hence, the arc length is computed as follows

$$\hat{f}(x) = \int_0^l \left[1 + \left(w_{\max} \frac{\pi}{l} \cos \frac{\pi}{l} x \right)^2 \right]^{1/2} dx = l_0 = l + u_B \quad (2)$$

After modification the Eq. 2, we get

$$\int_0^{l_0 - u_B} \left[1 + \left(w_{\max} \frac{\pi}{l_0 - u_B} \cos \frac{\pi}{l_0 - u_B} x \right)^2 \right]^{1/2} dx - l_0 = 0 \quad (3)$$

Solving the Eq. 3, the relation between the maximum lateral and axial displacement is

$$\frac{\pi^2 w_{\max}^2}{2(l_0 - u_B)} - u_B = 0 \qquad (4)$$

As it can be seen, the Eq. 4 is not depended on the beam cross-sectional parameters. Therefore, only the beam lengths are enough to be taken into account.

Let us consider an elastic part of the load – axial displacement and the load – lateral displacement curve as a linear function. When the buckling load has the same value at both approaches and both lines start at zero, *u* should be linearly depended on *w*. This assumption is greatly simplified, but acceptable on the borders of our use.

When performing the experiments, six different lengths and two diameters of the steel tubes with flattened ends were used. We continued on the research which was aimed at the investigation of a tube ends flattening effect on the critical buckling force [10]. The following parameters of tubes were used:

Table 1. The dimensions of the steel tubes

d_{ext} (mm)	l (mm)					
12	436	482	532	578	624	672
14	520	574	632	690	742	798

* the thickness of the tubes was 1 mm

These lengths correspond to the slenderness of 112, 124, 136, 148, 160, and 172. All specimens belong to the elastic buckling area.

Figure 2 shows a typical curve for the axial load as a function of the axial and lateral displacement obtained in the buckling test.

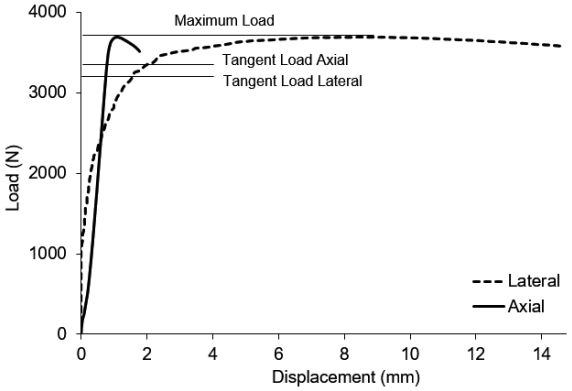

Fig. 2. Course of the Axial Load

For a test evaluation, three values of the load were taken from the graph. The first one was the maximum value of the axial load (LM), the second one was the maximum tangent value of the load – axial displacement relation (LAD) and the last one was the maximum tangent value of the load – lateral displacement relation (LLD) as shown in Fig. 2.

3. RESULTS

On the basis of Eq. 4, 12 different courses for the axial – lateral displacement relations can be built. Due to their high similarity, we have limited on the shortest and the longest specimen length, where behaviours are shown in Fig. 3 and 4.

When considering the interchangeability of the LAD and LLD approaches, the axial displacement should be in a linear dependence on the lateral one and so a linear trend line is modelled there. From the experiment, an area of linear load increasing is situated between 0.7 and 2.0 mm of axial displacement depending on the tube length and diameter. When making a trend line through this curve area, the coefficients of correlation are higher than 0.99, which means a good agreement with the linear function.

A paired t-test was performed for knowledge of significance between the load obtained by the LAD and LLD approach. Despite some significant discrepancies between the ones, the average discrepancy of the load means is 3%, which is negligible in practice.

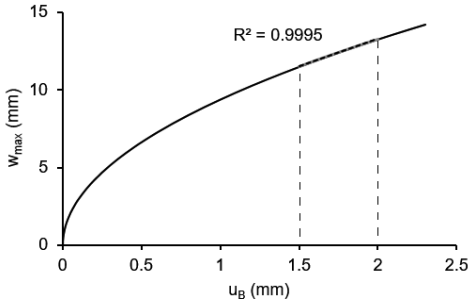

Fig. 3. The axial-lateral displacement relation for the beam d_{ext} = 12 mm; l_0 = 436 mm

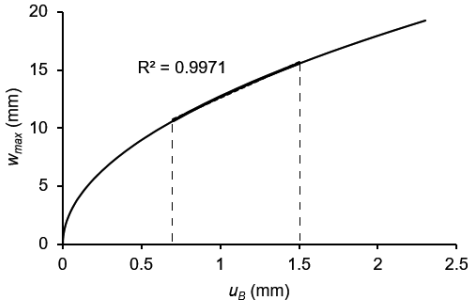

Fig. 4. The axial-lateral displacement relation for the beam d_{ext} = 14 mm; l_0 = 798 mm

Fig. 5 and 6 show the standard deviation intervals of measured buckling loads, where proximity of the LAD and LLD can be seen.

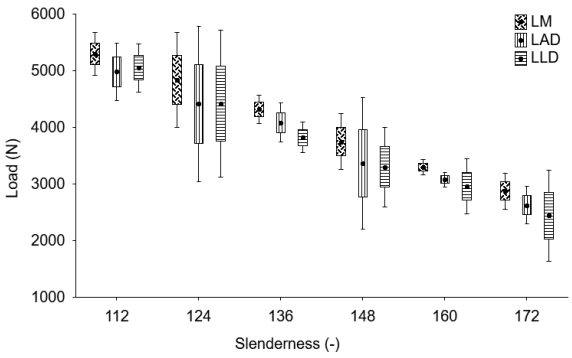

Fig. 5. Standard deviation intervals of the LM, LAD and LLD approaches for d_{ext} = 12 mm

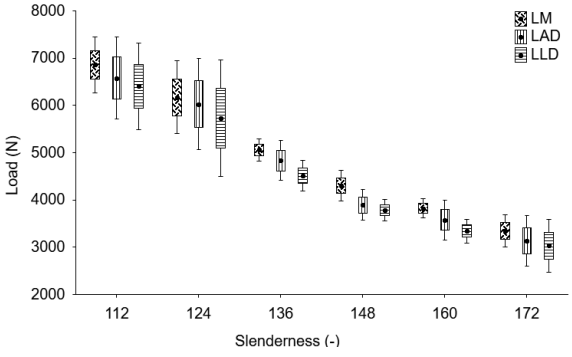

Fig. 6. Standard deviation intervals of the LM, LAD and LLD approaches for d_{ext} = 14 mm

Fig. 7 and 8 show the 95% confidence intervals of measured buckling loads.

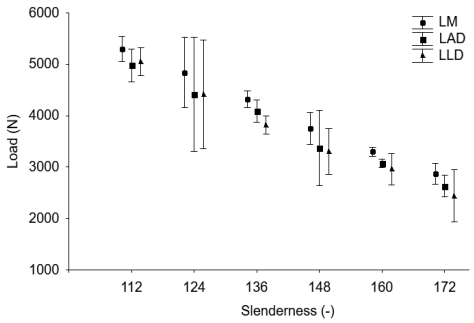

Fig. 7. Comparison between the LM, LAD and LLD approaches for d_{ext} = 12 mm

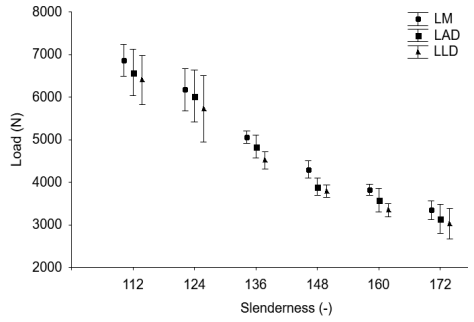

Fig. 8. Comparison between the LM, LAD and LLD approaches for d_{ext} = 14 mm

4. CONCLUSIONS

As shown in the results, there are no significant discrepancies between the LAD and LLD approaches. Therefore, we may prefer the method which is easier and more suitable in a concrete situation. Mostly, it is the relation between the axial load and axial displacement. It is not depended on a lateral deformation direction of a specimen. In particular, a specimen deformation at the spatial stability lose is sometimes hard to predict. In this case, the measurement of the axial displacement for the buckling load evaluation is easier. Last but not least, modest sensor technology can be used for this experiment.

5. ACKNOWLEDGEMENTS

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Exergy Destruction Minimisation of a Regenerative Brayton Cycle

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Abstract

In this paper, a Brayton cycle with regenerator in which an air is preheated by the exhaust gases leaving the turbine is analysed. In the model, by utilizing the air-standard assumptions, the combustion process is replaced by a constant-pressure heat-addition process in the heat exchanger where the air is heated by the stream of constant temperature. The regenerative Brayton cycle is optimized using the three criteria: the maximum effective specific work out, the maximum thermal efficiency of the cycle and the minimum exergy destruction of the cycle. The processes in the turbine and compressor are adiabatic, with the given values of their isentropic efficiencies. The analysis is performed in the non-dimensional form, using the pressure ratio as variable, in the interval from 2 to 20. The effect of the regenerator on the thermal and exergy efficiency of the cycle is presented and the criterion which refers to the justification of the installation of the regenerator is given.

Keywords: regenerative Brayton cycle, thermal efficiency, exergy efficiency, exergy destruction

1. INTRODUCTION

The Brayton cycle represents the operation of a gas turbine engine. Gas turbines have many advantages, like low capital cost to power ratio, high flexibility, high reliability without complexity, short delivery time, early commissioning and commercial operation and fast starting–accelerating, but low thermal efficiency, about 40%, is their main disadvantage [1]. Therefore, different processes are added to the basic cycle to improve thermal efficiency. One of the most known ways to improve the thermal efficiency of the Brayton cycle is the simple regenerative Brayton cycle. In the regenerator the heat from the exhausted gases leaving the turbine is utilized for preheating the airflow before it enters the combustions chamber. Regenerative Brayton cycle has greater thermal efficiency at low pressure ratio, but its efficiency decreases at high pressure ratio, [2]. Cheng and Chen [3] investigated the effect of regeneration on the power output and thermal efficiency in an endoreversible, regenerative Brayton cycle. They calculated the maximum power output and the corresponding thermal and the second law efficiencies using the optimum values of cycle temperatures. Medina, Roco, and Hernandez [4] applied the method of power density maximization (output power per maximum specific volume in the cycle) to regenerative gas turbines and showed that the thermal efficiency at the maximum power density may be greater or smaller than the thermal efficiency at the maximum power output depending on the value of the recuperator effectiveness. Chen et al. [5] theoretically analysed a closed, regenerative, internally irreversible Brayton cycle with variable temperature heat reservoirs. Haseli [6] performed an analysis of the regenerative, open Brayton cycle and its optimization on the basis

of the maximization of work output and thermal efficiency and the minimization of entropy generation. Durmusoglu and Ust [7] optimized an irreversible regenerative closed Brayton using a thermoeconomic objective criterion which is defined as the ratio of net power output to the total cost rate. Recently, Živić et al. [8] conducted the optimization of regenerative Brayton cycle with respect to three different thermodynamic criteria by using two concise diagrams for each criterion.

Exergy is a measure of the usefulness or quality of an energy form. It can be defined as the maximum amount of work that can be produced by a system or a flow of matter or energy, as it comes to equilibrium with an environment, [9]. Exergy analysis is used to detect and quantify the causes of the thermodynamic imperfection of the process being considered and indicate the possibilities for thermodynamic improvement of the process, [10].

In the present study the optimization of a regenerative Brayton cycle by the maximization of the thermal efficiency, maximization of the work output and minimization of the exergy destruction is performed.

Also, the effectiveness of the regenerator installed between the compressor and turbine is investigated.

2. MATHEMATICAL MODEL

Gas turbine engines usually operate on an open Brayton cycle. Air at ambient conditions is sucked into the compressor, where its temperature and pressure are raised. The high-pressure air then enters the combustion chamber, where the fuel is burned at constant pressure. The resulting high-temperature gases then enter the turbine, where they expand to the atmospheric pressure while producing power. The exhaust gases leaving the turbine are dumped into the atmosphere.

In our model, by utilizing the air-standard assumptions, the combustion process is replaced by a constant-pressure heat-addition process where air is heated in the heat exchanger from the stream at constant temperature. Also, in the regenerative Brayton cycle, the regenerator is installed between the compressor and turbine.

The scheme of the gas turbine engine is shown in Fig. 1 and Brayton cycle in the temperature-entropy (T,s) diagram in Fig. 2.

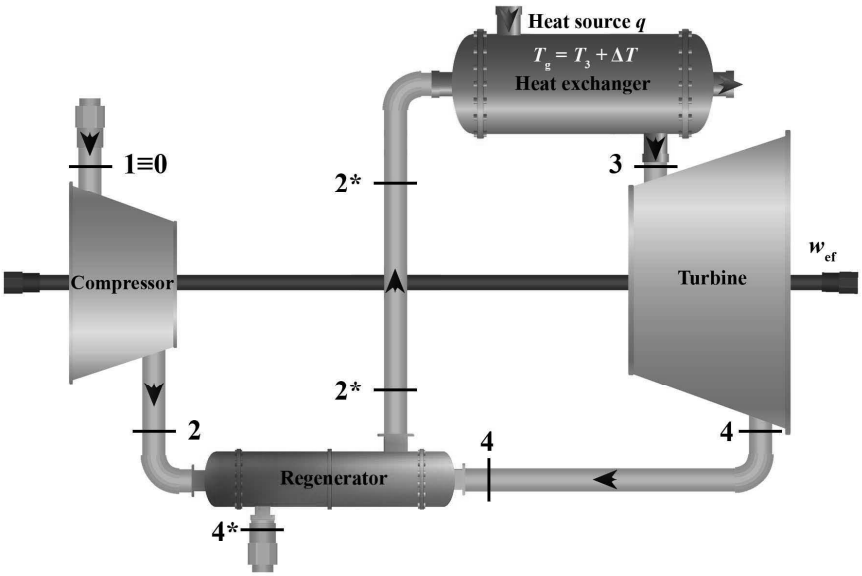


Fig. 1. Schematic view of the gas turbine engine

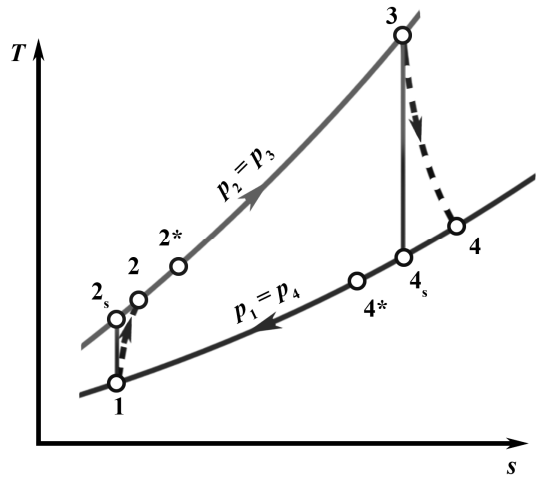


Fig. 2. T,s diagram of the regenerative Brayton cycle

In the compressor, the air at state 1, considered as ideal gas, is adiabatically compressed to state 2, at pressure p_2, whereby friction is taken into account. After that, air enters the regenerator, where is heated at pressure 2, by the hot exhaust gases leaving the turbine, to state 2*. The preheated air after leaving the regenerator enters the heat exchanger where is heated by the stream at constant temperature T_g to state 3 in which the temperature T_3 is usually prescribed. The air, after that, enters the turbine where is adiabatically, with friction, expanded to state 4*, flows through regenerator, and then coming out into the atmosphere at known state, pressure p_0 and temperature T_0. The pressure drops in the heat exchanger and regenerator are neglected, so it is: $p_2 = p_{2*} = p_3$, and $p_3 = p_{4*} = p_4$.

2.1. Energy analysis of the Brayton cycle

Heat added to the air in the heat exchanger is defined with the following expression

$$q = C_{\mathrm{mp}}(T_3 - T_{2*}) \tag{1}$$

Effective specific work output at the turbine exit is

$$w_{\mathrm{ef}} = w_{\mathrm{comp}} + w_{\mathrm{turbine}} = C_{\mathrm{mp}}\left[(T_1 - T_2) + (T_3 - T_4)\right] \tag{2}$$

The following expressions are taken into consideration

$$\lambda = \left(\frac{p_2}{p_1}\right)^{\frac{\kappa-1}{\kappa}} \tag{3}$$

$$\eta_{\mathrm{c}} = \frac{T_1 - T_{2\mathrm{s}}}{T_1 - T_2};\ \eta_{\mathrm{t}} = \frac{T_3 - T_4}{T_3 - T_{4\mathrm{s}}} \tag{4}$$

$$\varepsilon_{\mathrm{reg}} = \frac{T_{2*} - T_2}{T_4 - T_2} \tag{5}$$

$$r_{\mathrm{T}} = \frac{T_3}{T_1} \tag{6}$$

Energy equation for the regenerator can be written in the following form

$$T_2^* - T_2 = T_4 - T_4^* \tag{7}$$

Heat added to the air in the heat exchanger is expressed in the non-dimensional form

$$\frac{q}{C_{\mathrm{mp}}T_1} = r_{\mathrm{T}} - 1 + (1-\lambda)/\eta_{\mathrm{c}} - \varepsilon_{\mathrm{reg}}\left(r_{\mathrm{T}} - \eta_{\mathrm{t}} r_{\mathrm{T}}(1 - 1/\lambda) - 1 + (1-\lambda)/\eta_{\mathrm{c}}\right) \tag{8}$$

The extreme of the above function we shall find from the condition

$$\frac{\mathrm{d}}{\mathrm{d}\lambda}\left(\frac{q}{C_{\mathrm{mp}}T_1}\right) = 0 \tag{9}$$

Maximum of this function exists for the following value of λ.

$$\lambda = \sqrt{\frac{\varepsilon_{\mathrm{reg}}\eta_{\mathrm{c}}\eta_{\mathrm{t}} r_{\mathrm{T}}}{1 - \varepsilon_{\mathrm{reg}}}} \tag{10}$$

We assume that value of pressure ratio p_2/p_1 lies in the interval $2.0 \le p_2/p_1 \le 20.0$ which means that value of λ lies in the interval $1.219 \le \lambda \le 2.353$ for the value of heat capacity ratio 1.4. By incorporating the equation (9) in the equation (8) the value of non-dimensional maximal heat added to the air in heat exchanger can be obtained which will be presented in the chapter with the results of the calculation.

Equation (2) in the non-dimensional form is the following:

$$\left(\frac{w_{\mathrm{ef}}}{C_{\mathrm{mp}}T_1}\right) = \eta_{\mathrm{t}} r_{\mathrm{T}}(1 - 1/\lambda) - \frac{\lambda - 1}{\eta_{\mathrm{c}}} \tag{11}$$

This function has the extreme, the local maximum, for the following value of λ

$$\lambda = \sqrt{r_T \eta_c \eta_t} \tag{12}$$

The expression for maximum effective specific work output is obtained by substituting equation (11) in equation (10).

$$\left(\frac{w_{ef}}{C_{mp} T_1}\right)_{maks} = \eta_c \left(\sqrt{\eta_t \eta_c r_T} - 1\right)^2 \tag{13}$$

In the present analysis, we assume that all values, except the value of λ, are known, so the only variable is λ.

The thermal efficiency of the Brayton cycle is obtained by dividing the equation (10) with the equation (8)

$$\eta = \frac{\eta_t r_T (1 - 1/\lambda) - \frac{\lambda - 1}{\eta_c}}{r_T - 1 + (1-\lambda)/\eta_c - \varepsilon_{reg}\left(r_T - \eta_t r_T (1 - 1/\lambda) - 1 + (1-\lambda)/\eta_c\right)} \tag{14}$$

The extreme of the above function, because of its complexity, can not be obtained explicitly like in the previous two cases. This maximum will be obtained numerically, which will be presented in the chapter with the results of the calculation.

2.2. Exergy analysis of the Brayton cycle

Exergy analysis is carried out using the second law of thermodynamics. Since, in the analysis the pressure drops in the regenerator and heat exchanger are neglected, the irreversibility and related exergy destruction in the considered cycle are caused by the heat transfer between the streams of different temperatures and adiabatic process with friction in the compressor and turbine. The exergy destructions in the compressor, turbine, regenerator and heat exchanger are calculated individually and then for the whole cycle.

The known equation for the exergy of the ideal gas stream is

$$X = q_n \left[H_m - H_{m0} - T_0 (S_m - S_{m0})\right] = q_n \left[C_{mp}(T - T_0) - T_0 \left(C_{mp} \ln \frac{T}{T_0} - R_m \ln \frac{p}{p_0}\right)\right] \tag{15}$$

The expression for the exergy transferred by the heat in the heat exchanger with one stream at constant temperature T_g is

$$X_{heat} = \Phi \left(1 - \frac{T_0}{T_g}\right) \tag{16}$$

EXERGY DESTRUCTION IN THE COMPRESSOR

Compressor with the exergies at the entrance and exit is schematically shown in Fig. 3.

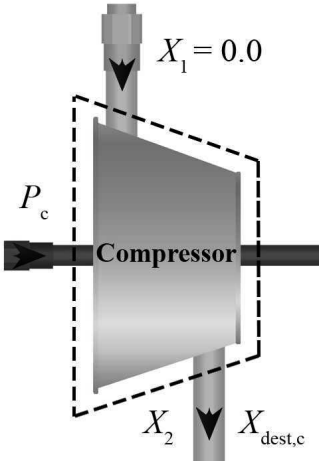


Fig. 3. With the exergy balance of the compressor

Exergy destruction in the compressor follows from the exergy balance of the compressor

$$X_{dest,\,c} = |P_c| - X_2 \tag{17}$$

and can be transformed in the non-dimensional form:

$$\frac{X_{dest,c}}{C_{mp} T_{ok}} = \ln \frac{\eta_c - 1 + \lambda}{\eta_c \lambda} \tag{18}$$

EXERGY DESTRUCTION IN THE TURBINE

Turbine with the exergies at the entrance and exit of the turbine are schematically shown in Fig. 4.

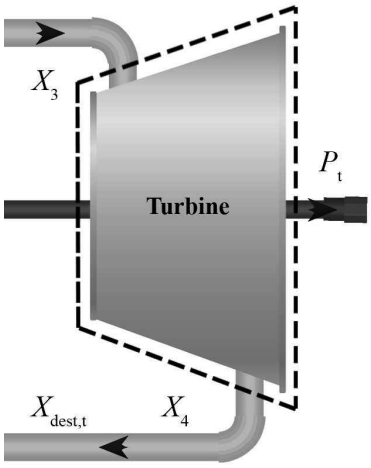


Fig. 4. With the exergy balance of the turbine

The exergy destruction in the turbine follows from the exergy balance of the turbine

$$X_{\text{dest,t}} = X_3 - X_4 - P_t \tag{19}$$

and can be transformed in the non-dimensional form:

$$\frac{X_{\text{dest,t}}}{C_{\text{mp}}T_{\text{ok}}} = \ln\left[\lambda\text{-}\eta_t(\lambda-1)\right] \tag{20}$$

EXERGY DESTRUCTION IN THE REGENERATOR

Exergy balance of the regenerator is schematically shown in Fig. 5

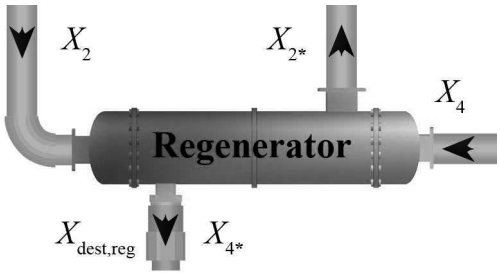


Fig. 5. With the exergy balance of the regenerator

and the expression for the exergy destruction in the regenerator follows from the exergy balance of the regenerator:

$$X_{\text{dest,reg}} = X_2 - X_{2*} + X_4 - X_{4*} \tag{21}$$

In the non-dimensional form, this destruction is

$$\frac{X_{\text{dest,reg}}}{C_{\text{mp}}T_{\text{ok}}} = \ln\frac{1\text{-}\frac{1\text{-}\lambda}{\eta_c}+\varepsilon_{\text{reg}}\left[r_T-\eta_t r_T(1-1/\lambda)-1+\frac{1\text{-}\lambda}{\eta_c}\right]}{1\text{-}\frac{1\text{-}\lambda}{\eta_c}} +$$

$$\ln\frac{\left[r_T-\eta_t r_T(1-1/\lambda)\right]\left(1-\varepsilon_{\text{reg}}\right)+\varepsilon_{\text{reg}}\left(1\text{-}\frac{1\text{-}\lambda}{\eta_c}\right)}{r_T-\eta_t r_T(1-1/\lambda)} \tag{22}$$

EXERGY DESTRUCTION IN THE HEAT EXCHANGER

Fig. *6* schematically shows the heat exchanger with the exergies at the entrance and exit

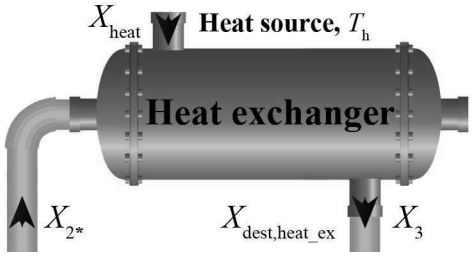


Fig. 6. With the exergy balance of the heat exchanger

Exergy destruction in the heat exchanger follows from the exergy balance of the heat exchanger

$$X_{\text{dest, heat\_ex}} = X_{2*} + \Phi\left(1-\frac{T_0}{T_g}\right) - X_3 \tag{23}$$

and in the non-dimensional form it is

$$\frac{X_{\text{dest, heat\_ex}}}{C_{\text{mp}}T_{\text{ok}}} = \ln\left(\frac{r_T}{1\text{-}\frac{1\text{-}\lambda}{\eta_c}+\varepsilon_{\text{reg}}\left[r_T-\eta_t r_T(1-1/\lambda)-1+\frac{1\text{-}\lambda}{\eta_c}\right]}\right) -$$

$$\frac{r_T-\left\{1\text{-}\frac{1\text{-}\lambda}{\eta_c}+\varepsilon_{\text{reg}}\left[r_T-\eta_t r_T(1-1/\lambda)-1+\frac{1\text{-}\lambda}{\eta_c}\right]\right\}}{r_T+\frac{\Delta T}{T_1}} \tag{24}$$

where $\Delta T = T_g - T_3 = 100$ K .

EXERGY DESTRUCTION OF THE BRAYTON CYCLE

The exergy efficiency of the whole cycle, according Fig. 7, can be expressed in the following form

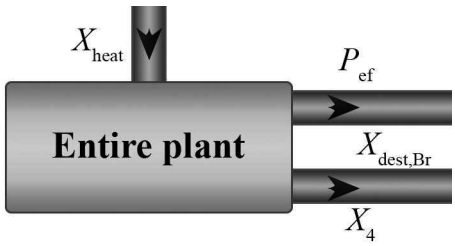


Fig. 7. With the exergy balance of the entire plant

$$\eta_{ex} = \frac{w_{ef}}{q\left(1-\frac{T_0}{T_g}\right)} \tag{25}$$

$$\eta_{ex} = \frac{\eta_t r_T\left(1-1/\lambda\right)-\frac{\lambda-1}{\eta_c}}{\left(r_T-1+\left(1-\lambda\right)/\eta_c-\varepsilon_{reg}\left(r_T-\eta_t r_T\left(1-1/\lambda\right)-1+\left(1-\lambda\right)/\eta_c\right)\right)\left(1-\frac{T_0}{T_g}\right)} \tag{26}$$

The exergy destruction of the recuperative Brayton cycle follows from the exergy balance of the cycle

$$X_{dest,Br} = \Phi\left(1-\frac{T_0}{T_g}\right) - X_{4^*} - P_{ef} \tag{27}$$

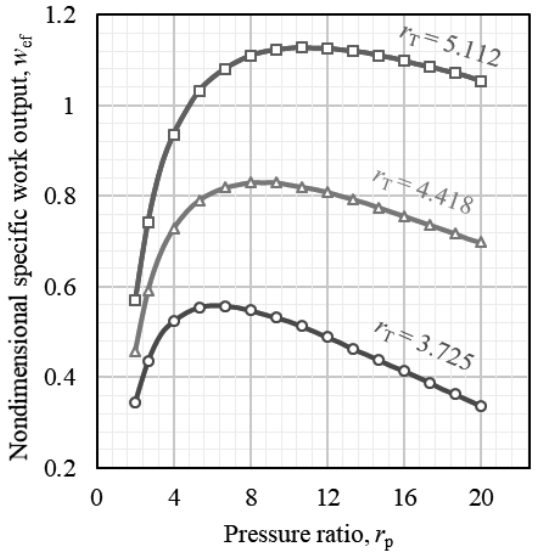
where $P_{ef} = P_t - P_c$

By dividing the equation (27) with the product ($C_{mp}T_{ok}$) we get the expression for $X_{dest,Br}/(C_{mp}T_{ok})$, which is equal to sum of the exergy destructions of the compressor, turbine, regenerator and heat exchanger.

3. RESULTS AND DISCUSSION

In the present numerical analysis the next three values of the air temperatures at the entrance of the turbine are taken: T_3 = 800, 1000 and 1200 °C. For the regenerator effectiveness the following values are varied: ε_{reg} = 0.0; 0.25; 0.50 and 0.75. The state of the ambient is defined with the pressure p_0 = 1 bar and temperature T_0 = 288.15 K, and this is the state of the air at the entrance of the compressor. It is assumed that the air is ideal gas with the constant value of molar heat capacity.

Diagram in



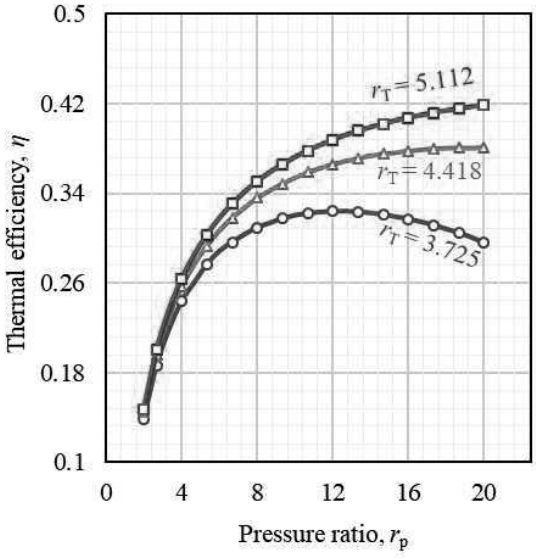


Fig. 8 (left) shows the non-dimensional specific effective work of the Brayton cycle as a function of pressure ratio r_p. Parametric quantity is the temperature ratio $r_T = T_3/T_1$ whose values are 3.724; 4.418 and 5.112.

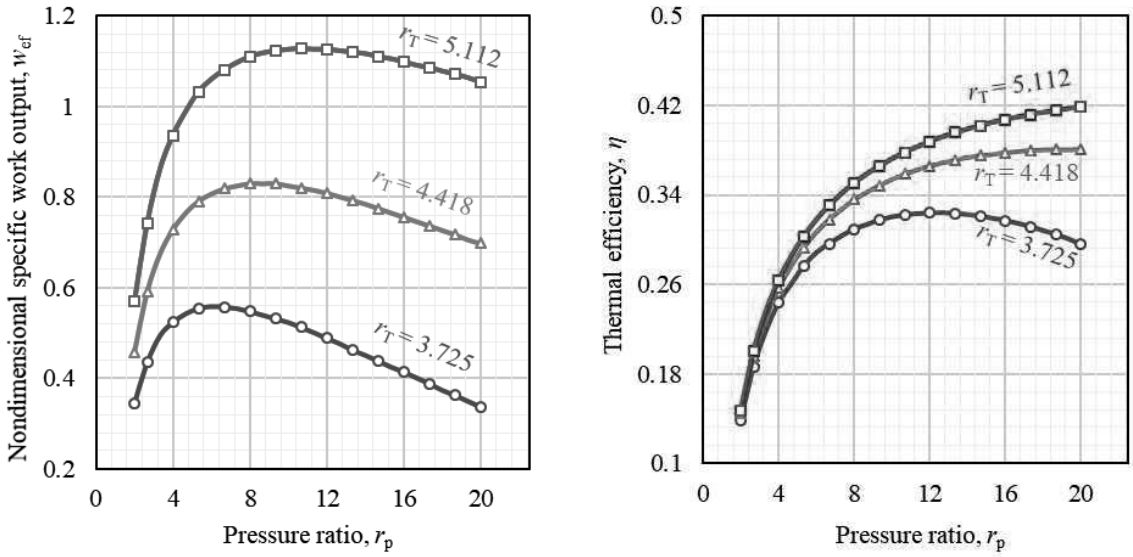


Fig. 8. Variation of the effective specific work output (left) and the thermal efficiency (right) with respect to r_p for various r_T

The each curve in

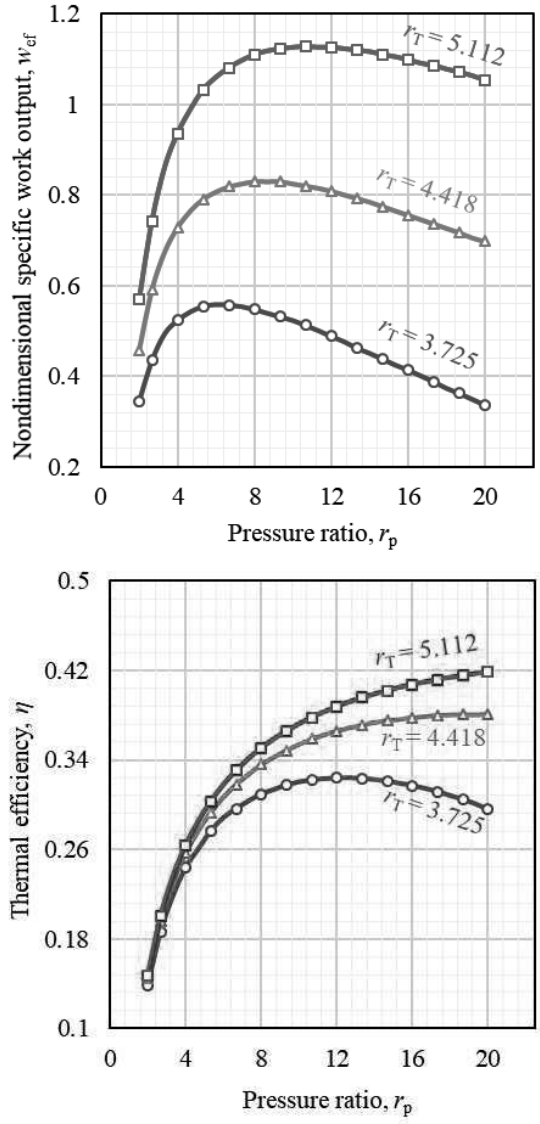
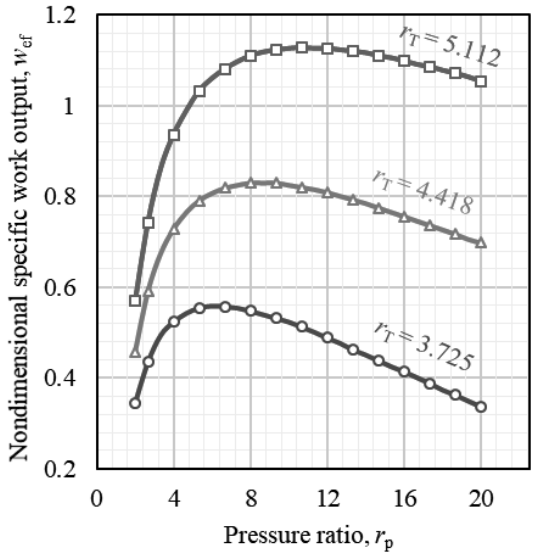


Fig. 8 (left) has a maximum and for the greater value of r_T the maximum has a higher value. The optimum value $r_{p,opt}$, in which effective specific work output has a maximum is moved to higher values for the greater value of r_T. The effective specific work output is not dependent on the regenerator effectiveness because the regenerator has no effect on the work output.

Diagram in



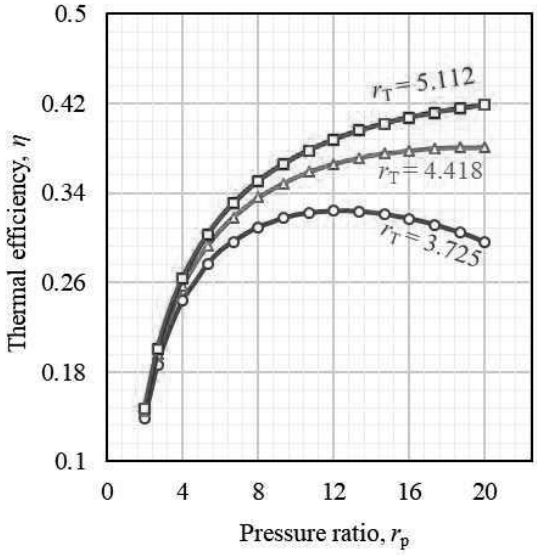
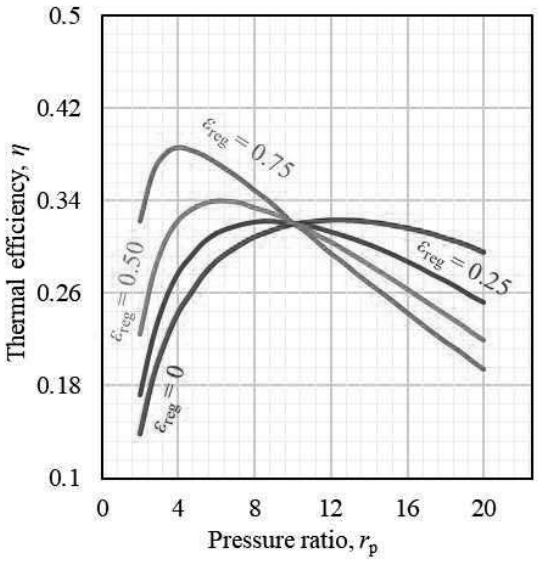


Fig. 8 (right) shows the thermal efficiency of the Brayton cycle as a function of r_p for defined parametric values of r_T. It can be seen that the thermal efficiency is higher for the greater values of r_T. Also, each curve has a maximum for the value $r_{p,opt}$ which is greater for the greater value of r_T.

Diagrams in Fig. 9 show the thermal efficiency of the Brayton cycle as a function of r_p for different values of regenerative effectiveness; for isentropic efficiencies of compressor and turbine, η_c = 0.85; η_t = 0.90. Fig. 9 (left) refers to value of r_T = 3.725 and Fig. 9 (right) to r_T = 5.112.



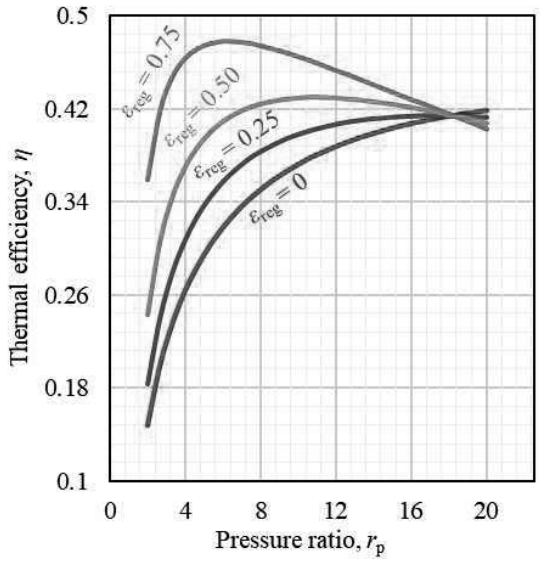


Fig. 9. Variation of the thermal efficiency with respect to r_p for various ε_{reg} (η_c = 0.85; η_t = 0.90) with due respect of r_T = 3.725 (left); r_T = 5.112 (right)

From the diagram in Fig. 9 (left) it can be seen that for each parametric value of regenerator effectiveness, the maximum value of thermal efficiency is achieved. The optimum value of r_p, because of complexity of the function for thermal efficiency (expressed by the equation 13) can not be found; but numerical values from the output file of the computer program can be read. For the value of $r_T = 3.725$ the pairs of values (r_p; η_{maks}) for $\varepsilon_{reg} = 0.0$; 0.25; 0.50 and 0.75 are (12.4; 0.3234); (8.80; 0.3218); (6.2; 0.3394) and (4.20; 0.3856).

With the increase of the $\varepsilon_{reg,}$ the values of $r_{p,opt}$ decreases. All curves of the thermal efficiency have one point of intersection, at value $r_p = 10.12$, and can be concluded that the regenerator's installation makes sense for the values of pressure ratio $r_p < 10.12$. In this interval the higher values of thermal efficiency are valid for greater values of ε_{reg} . For the $r_p > 10.12$ the installation of the regenerator is not physically justified.

As can be seen from the diagram in Fig. 9 (right), the trend of the curves are very similar as in the diagram in Fig. 9 (left). The point of intersection of all curves is at $r_p = 18.21$ ($\lambda = 2.29$). So, in the case of greater r_T the installation of the regenerator makes sense in the larger interval of the pressure ratio, for $r_p < 18.21$.

For the value of $r_T = 5.112$ the pairs of values (r_p; η_{maks}) for $\varepsilon_{reg} = 0.25$; 0.50 and 0.75 are: (17.2; 0.4143), (10.8; 0.4294) and (6.20; 0.4775). For $\varepsilon_{reg} = 0$, $r_{p,opt}$ is greater than 20 and the maximum cannot be seen in the diagram.

Diagrams in *Fig. 10* show the exergy efficiency of the Brayton cycle as a function of r_p for different values of regenerative effectiveness; for isentropic efficiencies of compressor and turbine, $\eta_c = 0.85$; $\eta_t = 0.90$. *Fig. 10* (left) refers to value of $r_T = 3.725$ and *Fig. 10* (right) to $r_T = 5.112$.

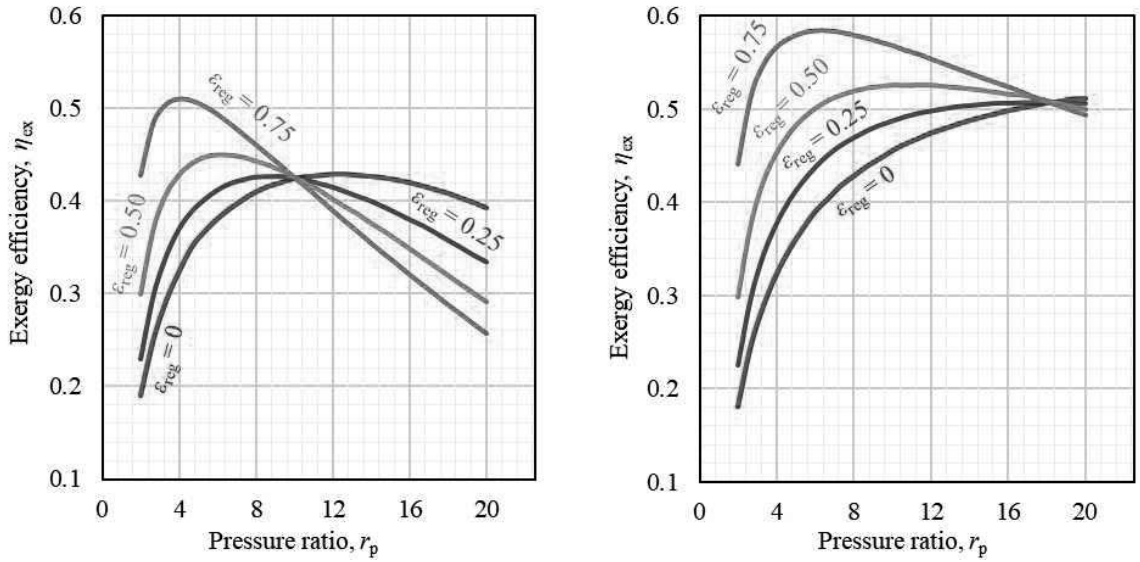


Fig. 10. Variation of the exergy efficiency with respect to r_p for various ε_{reg} ($r_T = 3.725$; and $T_0/T_g = 0.246$ - left); ($r_T = 5.112$; and $T_0/T_g = 0.183$ - right)

The curves of thermal efficiency and exergy efficiency are very similar. Cause lies in equations (13) and (26) and can be explained by the equation (25). It is clear that the exergy efficiency is greater than thermal efficiency.

For $r_T = 5.112$, the values $r_{p,opt}$ subject to maximum exergy efficiency, obtained for $\varepsilon_{reg} = 0.25$; 0.50 and 0.75 are: 0.5072; 0.5257 and 0.5846.

Diagrams in Fig. 11 show nondimensional exergy destruction in the individual elements of the Brayton cycle and total exergy destruction as functions of r_p for $r_T = 3.725$ and $r_T = 5.112$.

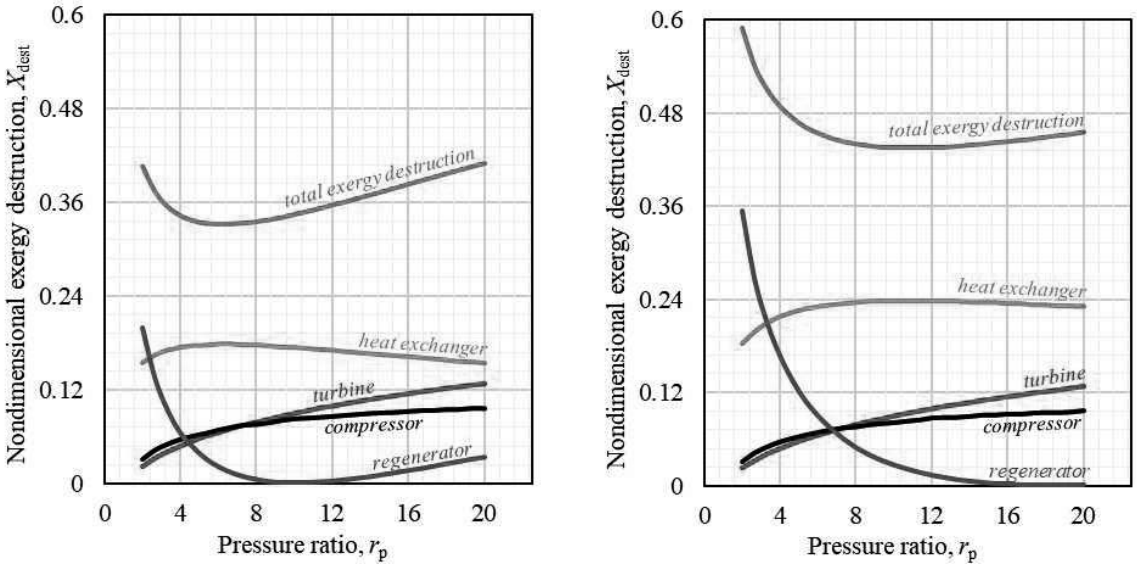


Fig. 11. Variation of the nondimensional exergy destruction in the compresor, turbine, regenerator and heat exchanger with respect to r_p *for* ε_{reg} = 0.50 *and* r_T = 3.725 *(left);* r_T = 5.112 *(right)*

It can be seen that the exergy destruction in compressor and turbine increases with the increase of r_p. The exergy destruction in the regenerator falls to zero and then increases. The total exergy destruction also has a minimum at the pressure ratio r_p = 6.24, (for r_T = 3.725). It should be noticed that the value r_p subject to maximum exergy efficiency is equal to value r_p subject to maximum thermal efficiency.

The total exergy destruction, for r_T = 5.112, has a minimum at value of pressure ratio r_p = 10.8.

Diagrams in Fig. 12 show the total exergy destruction as a function of r_p for values of regenerator effectiveness ε_{reg} = 0; 0.25; 0.50 and 0.75.

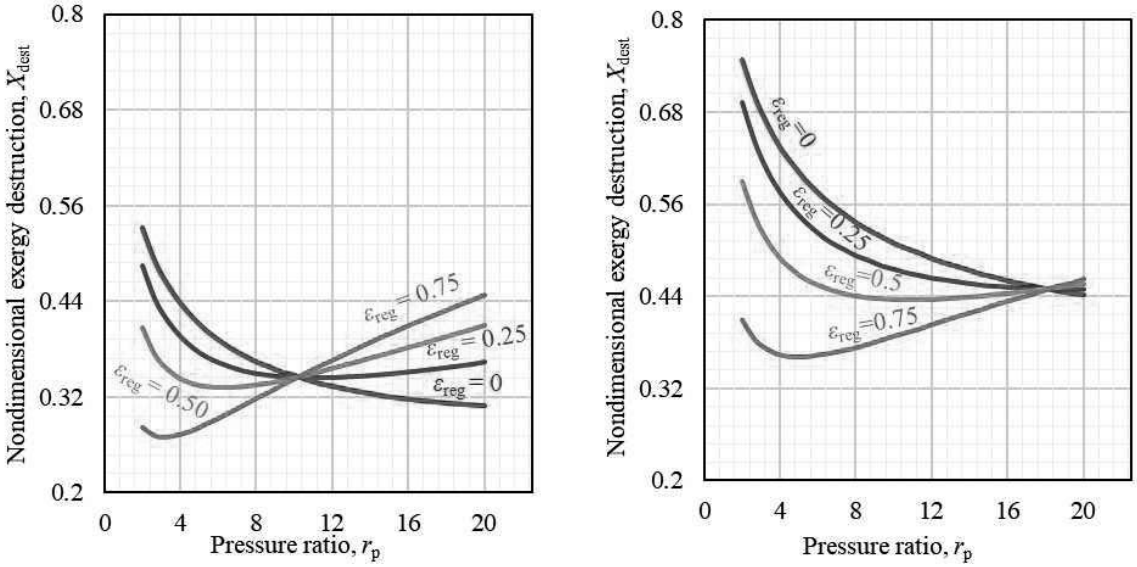


Fig. 12. Variation of the exergy destruction with respect to r_p *for various* ε_{reg}, r_T = 3.725 *(left);* r_T = 5.112 *(right)*

If there is no regenerator in the installation, the total exergy destruction continuously decreases with the increase of r_p. It can be seen in Fig. 12 (left), if the regenerator is installed, regardless of its effectiveness, for r_p < 10.12, each curve of the total exergy destruction has a minimum. The value of this minimum is less if the effectiveness is higher. For r_p > 10.12, the total exergy destruction continuously increases, which means that the existence of regenerator is

counterproductive. In the case r_T = 5.112, the limit value of pressure ratio to which makes sense to install the regenerator is 18.21.

Equation (28) gives the value of λ at which the temperature T_2 at the compressor exit is equal to the temperature T_4 at the turbine exit. It is clear that, at this value of λ , the exergy destruction in the regenerator is equal to zero. If the value of r_p (and appropriate value of λ) is greater than limit value, temperature T_2 is greater than temperature T_4 and in the regenerator the temperature of the air decreases because the heat is transferred from the air at the compressor exit to the air at the turbine exit. The existence of a regenerator, in this case, loses its meaning.

4. CONCLUSIONS

The carried out analysis showed that the regenerator has no effect on the maximum effective work output. The regenerator has a great effect on the thermal efficiency of the cycle, the total exergy destruction or exergy efficiency of the cycle. For the three investigated values of temperature ratio r_T = 3.724; 4.418 and 5.112, for the regenerator effectiveness ε_{reg} = 0.5 the values of optimal pressure ratio subject to maximum effective work out, maximum thermal efficiency and minimum exergy destruction are identical and they are: $r_{p,opt}$ = 6.248; 8.426 and 10.870 respectively. These results matched with the results of Haseli [11] who argues that the optimization based on the three criteria lead to different results for optimum pressure ratio; implying that the maximum work output, the maximum thermal efficiency, and the minimum entropy production are three different operational regimes, but, at a regenerator effectiveness of 0.5, these three optimization objectives become identical.

Then the analysis showed that increasing the value of the temperature ratio increases the interval of the pressure ratio in which the installation of the regenerator makes sense. For r_T = 3.724, this interval is $2.0 \le r_p < 10.12$; for r_T = 4.418, this interval is $2.0 \le r_p < 13.872$ while for r_T = 5.112 this interval is $2.0 \le r_p < 18.21$.

In all cases of r_T, the minimal values of exergy destruction are obtained for ε_{reg} = 0.75. The maximal exergy destruction takes place in the heat exchanger.

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Machine Learning Techniques for Smart Manufacturing: Applications and Challenges in Industry 4.0

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Abstract

The Industry 4.0 is now underway, changing traditional manufacturing into smart manufacturing and creating new opportunities, where machines learn to understand those processes, interact with environment and intelligently adapt their behaviour. Big data and artificial intelligence (AI) make machines in industrial production smarter than before addressing the question of how to build computers that improve automatically through experience. Machine learning (ML), as a subfield of AI, has become the main driver of those innovations in industrial sectors, which provides the opportunity to further accelerate discovery processes as well as enhancing decision making. However, ML algorithms learn directly from the examples, data and experience and are able to figure out how to perform important tasks by generalizing from them. This paper summarizes challenges and future trends of ML applications for smart manufacturing and provides an overview of several ML algorithms (e.g. support vector machine, k-nearest neighbour, neural network etc.) that are able to give the answers to those issues and avoid the potential problems in the future.

Keywords: artificial/computational intelligence, deep learning (DL), industry 4.0, machine learning (ML)

1. INTRODUCTION

The Industry 4.0 lays on the increment of available data sets. Different types of available, large and complex sets of data, namely big data, cannot be processed by using existing conventional technologies. Advanced methods, technologies, algorithms and software must be used in order to collect and extract data from the manufacturing environment [1]–[4]. Big data changes the way decisions are made inside the manufacturing environments based on different scientific areas such as computer science, mathematics and advanced statistics [4]–[6].

The field, that combines together all of these sciences is *machine learning* (ML) [4], [5]. ML is becoming the most important method that is used for predicting and classifying the difficulty solving problems inside the production systems [5]. ML uses increased computing power and various software for gaining the meaningful information and knowledge from the big data, which are collected from the environment, but also, has ability to learn from those data by getting the artificial/computational intelligence [5], [6]. For some specific tasks, ML is able to achieve a higher level of requirements than human. This highlights the importance of the big data from which the information is obtained. However, the balance has to be found. Too much information can lead to delay of the actions or the wrong conclusions of the certain problem and the lack of the information may not lead to problem solving [4]. Another great issue is related to security aspect of the data [7]. Having that issue in mind, ML has to utilize the different techniques and algorithms in order to achieve maximal benefit from the data [4], [6].

The most important techniques that are used for learning, classified by the available feedback, are supervised, unsupervised and reinforcement learning methods [8]. This paper focuses on the challenges and applications that ML faces with in today's manufacturing systems. Also, the accent is put on future trends of ML in manufacturing applications where the primary objective lays behind the utilization of big data in order to accomplish cost efficient, fault-free and optimal quality manufacturing process [9].

2. BACKGROUND

This section presents an overview of the related studies of Industry 4.0 and ML, as well as the ML techniques.

2.1. Industry 4.0 and Machine Learning

The rapid development of technologies interconnected with ICT and internet of things enables the growth of manufacturing which has led to the Industry 4.0 [10]. The implementation of CPS combined with IoT can provide intelligent, flexible systems capable of self-learning which presents the core of Industry 4.0 [1]. In order to achieve intelligent and flexible systems, the big data is required. In knowledge discovery in databases (KDD) of big data, machine learning plays an important role along with data mining, statistic, pattern recognition and other methods [11], [12]. ML, as a part of intelligent system in Industry 4.0, is broadly implemented in various fields of manufacturing where its techniques are designed to extract knowledge out of existing data [13]. The new knowledge (information) supports the process of decision-making or making prediction of manufacturing system. But the end goal of the ML techniques is detection of the patterns among the data sets or regularities that describe the relationships and structure between those sets [4].

2.2. Machine Learning techniques

ML system, that maps an input into an output, needs to be trained in order to learn. The system training is achieved by giving an input data and its corresponding output while determining the structure in the machine so that mapping can be learned [5].

Different researches have different approaches to structure the field of machine learning, but the structure that is most widely used is classified by learning processes, and that is supervised, unsupervised and reinforcement learning, shown in Figure 1 [4], [8], [14].

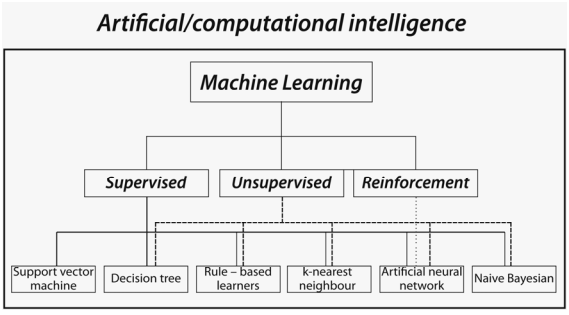

Fig 1. ML techniques and algorithm (adapted from [4]*)*

The supervised learning is machine learning technique, specified for large amount of input data (training sets), are applied to the systems where the correct response is provided by the knowledgeable expert [4], [5].

In supervised learning, a system is trained with data that has been labelled. The labels categorise each data point into one or more groups. Then the system learns how this training data is structured and uses this to predict in which categories to classify new output data [3]. The final goal of completed supervised learning process is that the outputs are close enough to be useful for all given input sets [15].

The most common supervised machine learning assignments are classification and regression [4], [16]. In classification assignments, the program has to learn how to predict the most likely category, class or label for discrete output values from one or more input data sets [16]. Similar to classification, regression problem, also requires supervised learning techniques. The difference in regression problems is that programs must foresee and predict the value of a continuous output by themselves [17].

According to Wuest et al. [4] as well as Jordan and Mitchell [18], the supervised learning is the most commonly used ML technique, because majority of applications can provide labelled data.

UNSUPERVISED LEARNING

The unsupervised learning represents the intelligent learning where evaluation of the action is not dependent, provided nor supervised, because there is no knowledgeable expert [4], [5], [15], [19]. Unlike supervised learning, the unsupervised learning does not learn from labelled data. Instead of that, it discovers patterns among the data [16].

The assignment of unsupervised learning is to discover groups of related observations of the input data, namely clusters [6]. Such observations within groups have cognation based on some similarly measurements where similar points are grouped together [6], [16]. The main goal of unsupervised learning is to discover the unknown relationships between classes using the clustering analysis [4]. According to Jordan and Mitchell [18] and Hackeling [16] the another unsupervised learning task is dimensionality reduction. It represents the process of discovering the relationships between input data sets and can be used for visualising. Considering that some problems might contain thousands and thousands of input data, problem with big data becomes impossible to visualize [16].

REINFORCEMENT LEARNING

Reinforcement learning presents another ML technique that has focus on learning from experience [4]–[6]. According to report of The Royal Society [6] and Jordan and Mitchell [18], reinforcement learning presents combination of unsupervised and supervised learning techniques, where the information available in the training data is intermediate between supervised and unsupervised learning, while Wuest et al. [4] and Hinton [5] consider it as “a special form of supervised learning”, known as semi-supervised learning.

Reinforcement learning system receives inputs while interacting with manufacturing environments and making sequential decisions in order to maximise future rewards [6]. It addresses assignments where some of the data presents labelled training sets and other data does not [5]. In reinforcement learning, instead of training datasets that indicate the correct output for a given input, the training datasets are presumed to provide only an indication whether an action is correct or not. If an action is not correct, there still remains the problem of finding the correct action [18].

3. ML ALGORITHMS IN MANUFACTURING

This section provides an overview of ML algorithms used in manufacturing processes.

3.1. Support Vector Machine

Support vector machine (SVM), a supervised learning algorithm, is used for linear as well as for non-linear problems, such as classification and regression [5], [16], [20]. SVM was formed based on the idea of creation the flat hyperplane or set of hyperplanes [21]. The hyperplanes divide the high-dimensional or infinite-dimensional vector space into distinguished parts with maximum margin distance between the two nearest training data points of classes [20], [21]. SVM test point of data is said to belong to one class if it is located below the hyperplane, and the other way around [21]. The mapping into an infinite-dimensional vector space is preformed by kernel functions which led to the main goal of SVM and that is fixing the computational predicting problems [21], [22]. The goal of an SVM is to produce a model, based on the training data, that predicts the test point of data where is needed a subset of the training data [5]. In order to achieve the goal, i.e. to achieve prediction of maximum accuracy, SVM requires a large sample size [23].

However, the advantage of SVM is its ability to work with incomplete data as well as the speed of classification. The biggest drawbacks

of SVM is slow speed of learning and its lack of explanation ability to humans [23].

3.2. Decision Tree

Decision tree is machine learning algorithm that is easily understandable and humans interpretable due to its graphical representation [5], [24]. The challenging issue is finding an optimal type of decision tree for training data sets. Two types of decision trees are mentioned by Hinton [5]. The first type is classification tree which gives a categorical output, while the second type is regression trees, which gives numerical output. Another disadvantage of decision tree is the inability to solve non-linear problems unlike the SVM algorithm, but it has quite high speed of learning [23]. Decision tree has wide utilization in exploration and prediction problems due to its ability to score so highly on critical features of data mining [25].

3.3. Rule – Based Learners

Rules-based learners, also known as expert systems [5], are considered to be one of the major forms of machine learning in combination with data mining. Also, rule-based learners are used for extraction the information based on statistical significance with the help of "if-then" rules [11]. Although they have application in both, supervised and unsupervised learning, they have the greater utilization in unsupervised learning environments for KDD due to its comprehensibility [23], [25]. As Hinton [5] and Kotsiantis [23] noticed, the drawback of rule-based learners is classification accuracy due to acquisition of the knowledge. However, classification accuracy can be improved by automatic feature construction algorithms and combining different characteristics where the background expert knowledge is used.

Another advantage of the rule-based learners is that the system is able to explain the process how the result was generated where the learning algorithm always methodically checks the entire sets of data [5]. Considering the noise, rule-based learners are resistant to it due to their pruning strategies which avoid overfitting the data [23].

3.4. k-Nearest Neighbour

The k-nearest neighbour (k-NN) is the ML algorithm used for non-linear problems, i.e. classification and pattern recognition that requires computation of distances between sample of data where each input data is labelled of its k closest neighbouring samples [26].

Ismail et al. [25] consider that k-NN as a prediction algorithm, similar to clustering due to its ability to predict and compare similarities of the big data. According to Kotsiantis [23], k-NN algorithm is very sensitive to data values that are missing, noisy, fuzzy, irrelevant and redundant, and the speed of classification is slow. That leads to accuracy in general which is quite low. Also, the k-NN is hard to interpret due to its unstructured collection of training big sets of data. Contrary to that, k-NN has a great speed of learning which makes it one the fastest learning ML algorithms [23]. Figure 4 represents an example of k-NN where the space is divided in four different areas by coloured circle. An empty circle presents a new data, which falls in green area.

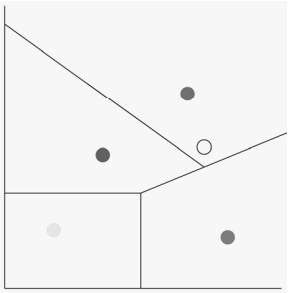

Fig 4. *An example of k-NN algorithm*

3.5. Naive Bayesian

Naive Bayesian (NB) represents ML algorithm, which is defined as a very simple model composed of acyclic graphs. Acyclic graphs of NB model have only one parent and multiple children. The parent represents the unobserved node, while the children are observed nodes [4], [23].

According to Kotsiantis [23], naive Bayesian algorithms are usually less precise that some other ML algorithm that are more sophisticated (i.e. ANN) due to the supposition of independence among children. The opposite of

Kotsiantis opinion, Hastie et al. [15] consider that NB algorithm can often outperform some more sophisticated algorithms due to the fact that it cannot affect the estimation dramatically and that NB has significant advantages over other algorithms.

Naive Bayesian is useful for problems related with classification, regression, clustering and others [27], [28]. Also, it requires little storage space during both stages: training and classification [4]. But the major advantages of the NB classifier are its short computational time for training, fast process of learning and ability of working with big, fuzzy, noisy and incomplete data [4], [23].

3.6. Artificial Neural Network

Artificial neural network (ANN) is ML model that is used for nonlinear classification and regression problems [11], [16], applied in various fields of manufacturing due to the fact that it plays an important role in today's problem solving by parallel processing, where it simulates the decentralized "computation" of the humans central nervous system. The ANN allows an artificial system to perform supervised, unsupervised and reinforcement learning assignments [4]. The challenging task for ANN is achieving the high accuracy where the big data is required. Another issues are related to dealing with overfitting, missing data values, speed of learning and complexity of the models they produce [23].

Similarly to SVM, ANN is capable of handling the high-dimensional data, continuous features and high-variance, but the process of learning is slow [23], [25]. The ANN is good for KDD for hidden patterns or trends due to its abilities of processing which has similarities with human brain [25]. In contrary to that, ANN requires complete records of data to do their work. In other words, the data must not be fuzzy, noisy or incomplete. Another drawback is that the large size of sample is required in order to achieve its maximum prediction accuracy [23]. The example of ANN algorithm is shown on Figure 5, where is presented the layers of which it is constructed. There it can be multiple hidden layers, not just one as presented. However, if there is a greater number of hidden layers with very large dataset, than is talked about deep neural networks (DNN) [29].

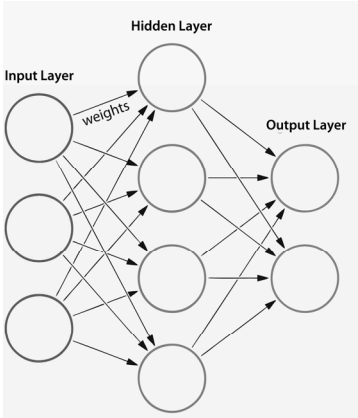

Fig 5. An example of ANN (adapted from [30]*)*

DNNs are based on fundamental concept of ANN. A deep structure of DNN exploits multiple hidden layers with multiple neurons in each layer, a nonlinear activation function, a cost function and a back-propagation [31] algorithm for information-processing in a hierarchical architecture for pattern classification problems [32].

In comparison with ANN architectures, DNNs are able to learn high-level features, which are more complex and abstract, by integrating feature learning [31] and model construction into a single model. That model is created by selecting different kernels or tuning the parameters by end-to-end optimization where the parameters of DNN model are trained jointly without human supervision [33], [34].

4. APPLICATIONS, CHALLENGES AND FUTURE TRENDS OF MACHINE LEARNING

Machine learning techniques bring many improvements inside the manufacturing environments. The conducted review led to identification of application, challenges and future trends of ML which are discussed in the following subsections.

4.1. Application

The application of ML techniques is in constant enlargement over the last couple of decades [35]. Growing application of ML has led to the availability of complex big data that has certain patterns [36], database technologies, computer power [37] and usability of ML techniques [4].

From the perspective of manufacturing, various types of big data sets can be captured, collected, extracted and analyzed in order to improve the traditional manufacturing systems [1], [37]. Finding the knowledge in big data and transforming it into information is done by KDD with the help of ML techniques [1]. According to Escobar Diaz and Morales-Menendez [37], the primary objective of ML applications in combination of big data analytics is the achievement of defect-free and fault-free processes.

Most of the manufacturing issues appertain under classification problems, where the experts of industrial field have to determine a label of the class to specific object or a situation based on the big data set [38]. Problems of classification do not have to be related only to manufacturing but can relate to the entire industry. As Rikalovic et al. [39] mentioned application of machine learning techniques in combination with ANFIS (adaptive neuro-fuzzy inference systems) that rely on expert knowledge has utilization in intelligent decision support system for industrial site classification.

The applications of ML in manufacturing refer to pattern recognition in existing sets of data. That is beneficial for development of foreseeing the future behaviour of the manufacturing system with the end goal of detecting the present behaviour patterns or regularities that describes relations between data [1], [4].

Another advantage of ML application is its ability to further improve the extracted knowledge by learning from results where ML has ability to create new valuable information [4]. As Pham and Afify [38] mentioned in their paper, the supervised ML technique is used for building a qualitative knowledge base where the results of a simulation experiment are used. Also, the supervised learning is employed for investigating the decision-making and process-planning problems in manufacturing [38].

Nowadays, the ML algorithms have wide utilization in different manufacturing areas such as optimization, troubleshooting and quality control [36]. The result of the scientific research has shown that ML techniques is consider to be a powerful tools for permanent quality improvement in a large and complex processes, e.g. semiconductor manufacturing [38].

Machine learning techniques have application in LEAN manufacturing systems as well by using just-in-time (JIT) and kanban tools. The results of implementation of ML into LEAN manufacturing systems show that the neural networks and decision trees represent two most practical algorithms with special abilities for adjusting the number of kanbans in a dynamic JIT manufacturing environments [38].

The ML has many security applications for controlling the access and verification. On the one hand, security application uses pattern recognition along with other methods where the goal is to decide if the given face needs to be classified or labelled as unfamiliar. On the other hand, the goal of verification is to decide whether person is the person he claim that he is while dealing with various conditions, e.g. lighting conditions, facial expressions etc. [35].

The application of ML algorithms such as k-nearest neighbour and naive Bayesian have utilization in building predicting models such as predicting the failure of airplane components before they stop working [38].

Another very important application of ML is related with transparency as “the ability of an organization to unravel and quantify uncertainties to determine an objective estimation of its manufacturing capability and readiness” [40]. The transparency can be achieved as reducing the complexity of the results where ML algorithms evolve the patterns from existing data and extracting the knowledge

used for decision-making and giving an approximations about future behaviour [4]. Also, as Lee and Lapira [41] and Lee et al. [42] stated that the increment of transparency in manufacturing environments has a number of advantages, but the application of ML leads to the major cost reduction in every aspect of the transparent manufacturing environment.

4.2. Challenges and future trends

Machine learning is still young scientific field that is growing rapidly due to its practical applications. Having that in mind, one of the major trends is related with the environment in which a ML algorithms operate due to issues of parallelism [43]. ML systems are interconnected with the complex software collections which run on computing platforms and provide a range of algorithms and services to data analysts [43]. Due to that, as mentioned before, trends but also the challenges are related with big data from which knowledge can be extracted [13].

Today, manufacturing is facing an increment of challenges related to complexity and dynamic behaviours [44] while adding the fact that the manufacturing is affected by uncertainty [4]. In other words, the constant enlargement of big data and its availability, high-dimensionality, variety as well as homogeneity represents the main challenges in manufacturing environment because the knowledge cannot be extracted. In order to overcome these challenges, the machine learning techniques and algorithms are used [4]. However, the gathered big data has tendency to contain irrelevant, missing and redundant information which can lead to the impact on the performance of the ML learning abilities [1].

The major concerns related with collecting new kinds of big data, motivated by its economic value, is privacy and security issues since the big data are stored in virtual cloud platforms [28], [43]. The misuse of big data in manufacturing, as well as in entire industry, is in increment, because of the wireless remote control of the physical devices. Therefore, it is possible to take control over the physical machinery if the data is not properly secured [45]. Due to such concerns, the additional researches are needed in order to improve the storage as well as the security of big data. However, sometimes the nature and size of big data does not allow the big data to be located in the single space, but has to be distributed over the distinct physical locations. In order to achieve connection as well as the learning system between the big data from the entire manufacturing environment the communications through wireless devices is required [43].

Another major challenge as well as the future trend is development of the ML algorithms as well as the improvement of existing ones implemented in manufacturing systems that are able to handle various situations and learn from them [1]. As the Wuest et al. [4] consider that the question what ML technique and algorithm to choose is a great issue due to their advantages and disadvantages. Because of that the so called “hybrid algorithms” that present the combination of various ML algorithms, are becoming more and more used in the flexible manufacturing systems [46]. However, the biggest challenge for the development and application of ML algorithms that manufacturing is facing today is finding the human experts in data science and optimization scientific fields having in mind that different skills are required [47].

5. DISCUSSION AND CONCLUSION

This paper provides the preliminary literature overview of the machine learning techniques as a part of intelligent system (i.e. supervised, unsupervised and reinforcement learning) and the mostly used algorithms as well as their advantages and disadvantages within the Industry 4.0. Due to the fact that there can be confusion when it comes to machine learning and statistics, a detailed comparison is given and the differences are presented between these two methods. Also, the application, challenges and future trends of machine learning represent the the main focus of this paper.

The application of ML is closely related to big data without which the development and implementation of ML techniques would not be possible due to the fact that extracting the knowledge is the most important action that lead to the achievement of defect-free and fault-free processes. Also, the further improvement of ML application enable the the learning process where the artificial/computational intelligence plays the most important role. Today, the ML algorithms have wide utilization in different manufacturing areas such as optimization, control, troubleshooting, security and verification where the increment of transparency of the entire manufacturing environment is beneficial for cost reduction without affecting quality of production. Also, ML algorithms have application in semiconductor as well as in LEAN manufacturing environments where the results of the experiment show an improvement in process quality.

Challenges and future trends in machine learning are closely related. All that represents the current challenges also represents the future trends in further research on ML techniques and algorithms. The most challenging assignment as well as the biggest trend is gathering the big data from the manufacturing environments in order to have enough extracted knowledge and information for developing the ML algorithms that are able to learn automatically from patterns and previous behaviour. Sometimes big data can be irrelevant, fuzzy, noisy and redundant which additionally complicates the learning process. Also, because of the fact that the extremely large amount of data is collected, the storage space represents the other challenging issue which leads to privacy, security and economic questions. However, still the biggest challenge and future trend that manufacturing is facing today is reflected in the further development and application of ML algorithms, but also finding the human experts in data science and optimization scientific fields represent another challenging issue. This paper is the initial part of the research, so in future its continuity will contribute to the further exploration and development of ML and its implementation inside intelligent manufacturing environments with focus on Industry 4.0.

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CAx Systems within the Engineering Educational Process

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Abstract

The article deals with the influence of CAx systems on engineering educational process. There are also analysed the requirements for the education development to increase its quality and wide key competencies in the article. The basic issues, that are necessary to consider to be the process of education more effective, are described in the paper. Authors also provide a basic overview of study at universities focusing on the technical fields of study. The main part of the manuscript is focused on the possibilities to use CAx systems within the technically oriented lessons as the tools of a modern approach to the schooling. Advantages and disadvantages of this modern approach to education enable to know its strengths and weaknesses. This know-how subsequently will allow to improve both professional and computer skills of students and so prepare them better for their career. In addition to computers, textbooks still remain a support tool for education as it was in a previous time period. New trends are also being introduced to prepare study materials to better explain the problem through visualization. They are described in the last part of the paper.

Keywords: engineering educational process, computer aid, development, requirements, e-documentation

1. INTRODUCTION

Education has a role to play in providing the skills and competencies needed to operate in this new world. It has the potential to influence the life outcomes of the most disadvantaged and is a powerful tool to reduce inequity. It can also help in teaching basic skills as well as instilling values and helping to define identity. Some of the ways education can affect and be affected by global trends are obvious and immediate, for example through the teaching of foreign languages, global competencies for business and trade, and raising awareness of climate change effects and science.

Investing time and money in education is an investment in human capital. For adults, the labour market outcomes of higher educational attainment outweigh the initial cost of pursuing education. Investment in education is costly in the short term but accrues benefits in the long term, in the form of better labour market prospects throughout an individual's working life.

In recent decades, access to tertiary education has expanded remarkably, involving new types of institutions that offer more choice and new modes of delivery. In parallel, the student population is becoming increasingly diverse in gender and in study pathways chosen. Students are also becoming more likely to seek a tertiary degree outside their country of origin. In most countries, the fields of science, technology, engineering, and mathematics are less popular. In half of the OECD and partner countries with data, the combined share of students graduating from the fields of natural sciences, mathematics and statistics, engineering, manufacturing and construction, and information and communication technologies is still lower than the share of students graduating from business, administration, and law. [1]

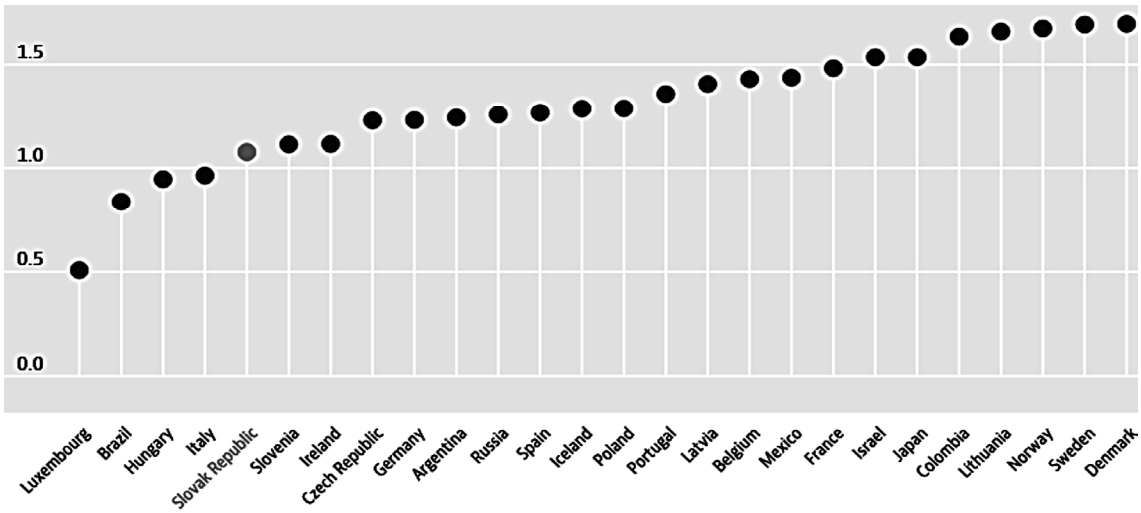

Fig. 1 Education spending per student and as a percentage of GDP [2]

Fig. 1 [2] shows education spending (per student and as a percentage of GDP) that covers expenditure on schools, universities and other public and private educational institutions. Spending includes instruction and ancillary services for students and families provided through educational institutions.

The relationship between per capita GDP and expenditure per student by educational institutions is difficult to interpret. However, there is a clear positive relationship between the two at both primary and secondary levels – in other words, less wealthy countries tend to spend less per student than richer ones. Although the relationship is generally positive at these levels, there are variations, even among countries with similar levels of per capita GDP. [2]

2. ENGINEERING EDUCATIONAL PROCESS

2.1. Requirements for the education development

In view of the ongoing development and trends, three main issues should be considered:

- In the mid and long-term horizon, a huge potential for creation of jobs, including new jobs, exists at the level of regions.
- Requirements for skills, abilities and qualifications will considerably increase for all types and levels of employment, which will require higher investments in education.
- It will be necessary to better harmonise the supply and demand for skills on the labour market that will be increasingly dominated by services, also through the system of monitoring and evaluation of needs of the labour market and cooperation of all concerned parties.

Deserved attention will have to be paid to issues of development of lifelong education and lifelong consultancy systems, as well as to new types of services of employment in a "region-specific" combination with other social services as open regional systems.

Recent advances in information and communication technology (ICT) have a profound effect on education. The world is also becoming increasingly interconnected and the connections are both officially established and spontaneously created. Most countries are rethinking their education systems with globalization in mind. These new developments require a re-evaluation of the goals and methods of education. The wide range of methods is used in engineering and science: general logic method, non-logic method and hypothesis method, mathematical method especially the numerical calculation and simulation method is in a wide range, including signal and image processing, control design, test and measurement, analysis and computations. [3]

Therefore, effective education has to be variable and adaptive to current situation. A good teacher understands that there are core skills and knowledge that have to be learned, but they have to be presented in a way that students find relevant, even if not in their immediate lives. The science of teaching requires content knowledge, organization, management skills, and detailed planning. The art of teaching is not about possessing an outgoing personality, but making connections to students, as well as connecting the curriculum to the real world in a relevant manner. Thus, today´s teachers should create and maintain relationships with their students for the sake of tomorrow's success.

2.2. CAx systems within the technically oriented lessons

Current education has to provide the general skills for all students and primarily reflect the actual and anticipated needs of labour on the market. The reforms in education system have to reflect a high degree of student freedom to choose a form and content of education. This has to be connected with universal sophisticated system of quality measuring of institutions, founders and the teaching. At the same time, it is necessary to innovate the school equipment at all levels of education to improve the relationship teacher-student. It requires the following general steps: [4]

- the contextual and procedural transition of the traditional school into a modern school with the implementation of changes to the program of teaching from information memorizing to the ability to acquire, to process and to use them,
- the supporting and improving of the education in: foreign languages, information technology, basic business knowledge and skills of every graduates,
- the quality of teachers increasing, especially by adding of the attractiveness for good-class teachers in their profession and by improving of conditions for teacher continuing education and skills development.

The key for the achieving of these goals is a flexible system in which universities react mainly to the requirements of young people, but also to the demand for lifelong learning of experts. Through their activities, the universities should also be the "engine" of social and economic development of region in which they are situated.

In Slovakia, the content and methods of teaching within the framework of individual subjects are in full competence of universities and faculties in agreement with fundamental rights and freedoms of higher education institutions. In higher education institutions the choice of teaching methods is determined by the type of teaching and specificities required from individual subjects. The determination of length of the practice teaching falls within the competence of the appropriate higher education institutions. Lectures, seminars, proseminars (combined form of teaching made up of lectures and seminars), exercises, courses, consultations, excursions, practice teaching, seminar papers are the main forms of teaching. In technical and science subjects it is a laboratory work. As a part of lectures, the dialogue methods are used combined with computer technology and other teaching aids. In seminar and practical parts of teaching a use is often made of simulation methods. [5]

Utilization of computer aid at the technically oriented lessons turns into certainty today. The most available and commonly used software in technical practice are: Autodesk Inventor, PTC Creo, Solid Works, CATIA, NX, Solid Edge and other. Fundamental properties of the software mentioned above are the parametric modelling and associative operation, what means that any change in construction activities will be reflected in the whole design and everything, what follows this change, is automatically updated.

The operating basis all of these software applications is 3D model. It is the reason why the teaching process, related to the technological devices design, starts off by creation three dimensional objects with required shape and

dimensions. Students learn to use available techniques of software as effectively as possible such that the part should be generated with the minimum number of steps. Primarily students learn to create simple shapes of the bodies and consequently the complexity of the part rise. Students are able to prepare 3D models of technical usage as it is shown in the Fig. 2.

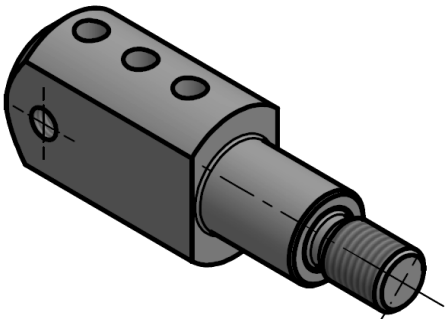

Fig. 2 Virtual model with basic shapes

Advanced modelling makes use of operations with surfaces, especially in automotive industry, so complex designs with unconventional shapes can originate. Virtual model can be generated as original (prototype) or as the imitation of existing body. Ones modelled enables not only visualization and quick modification of the object (the dimensions editing or designing of the similar entity), but it also enables an optimization of structural solution before the part production.

The next advantages of 3D model can be summarized to the following points: [6,7]

- Definition of the couples, loadings, materials and other 3D model properties allows to execute the various types of analysis on the object and so predicts the object behaviour in real conditions.
- Very simple preparation of the negative shape for manufacturing of mould.
- By means of the created 3D model it is possible to simulate the machining process and so to find out the collisions between the tool and the workpiece. Simulation of manufacturing operation allows to generate cutter location data and after the postprocessing to make the NC program for the selected control system of the machine in very short time.
- Movable sets are represented by various types of mechanisms e.g. quick return mechanisms, cam mechanisms, gear mechanisms, as well as machines or others. Students learn to execute the kinematics analysis of mechanism by three various methods (numerical, graphical and with computer aid) and so they can consider advantages and disadvantages of them. Students study planar mechanism, but the same principles can be used for space motion of mechanism in the future and real practice.

To understand the assembly behaviour, it is necessary to simulate the kinematics motion and within the software to define the joins through the easy connections as are pin, ball joints, sliders and other. After the mechanism modelling, after joints and input parameters specification, it is possible to activate kinematics or dynamic analysis. Output data can be displayed as values, vectors or as graphs, or it can be sent to other software for the next processing. The type of assembly with components motion in space is represented by robots. Special module of software application facilitates to imitate trajectory of every selected point and to generate a workspace of robot, so called working envelope. Created envelope can be saved as the virtual part for next usage. Figure 3 shows 3D model of manipulator with the force analysis in one of its hydraulic cylinders and its working envelope.

All parts and devices can be included to the production system. The modelling of the manufacturing process in real time is one of the most difficult parts of process planning, because it has to imply knowledge from all fields of production (design, technology, ergonomics, safety and other).

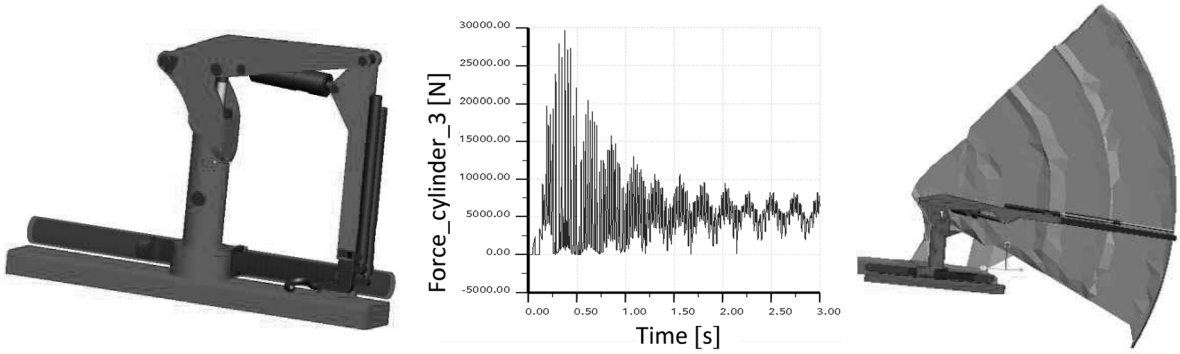

Fig. 3 Manipulator with output data of dynamic analysis and working envelope

The designing of the process is done step by step; at the first the features of process were prepared, then they were placed according to workspace plan and at the end the entire process was animated. The output of process planning is a movie file that can provide to the designers all collision places and so they can solve the problems before the workshop building.

Hardware and software represent tools that can help students with problems identification, with brainstorm ideas, with a discussion about possibilities, with testing ideas and drawing conclusions. However, it's not technology "itself" that facilitates learning. To achieve required results, it is necessary to prepare suitable textbooks and scripts for students in all types and stages of their study.

2.3. E-documentation as a tool for learning support

Higher education institutions are autonomous also in selection of textbooks or educational software as well as in their development. In case that a university teacher writes a university textbook this output is partially considered at determination of a subsidy for the given higher education institution. A special system of support at development of teaching materials, or university textbooks at the central level, does not exist. In some years, development projects were supported in higher education institutions, aimed at the use e-learning modules. [8]

Modern forms of electronic documentation enable to put in electronic documentation 3D models instead of classical pictures. It raises efficiency of education due to the possibility to handle 3D objects without necessity to buy of expensive CAD/CAM or simulate software. One of the formats that satisfy requirements mentioned above is PDF format achieved for all students. It provides the wide scale of set up possibilities so the transferred document very exactly adapts to the using purpose. Through the software Adobe Reader students (or other users) can rotate 3D objects to reach sufficient overview about the model. They can check the model display, detect model dimensions or they can make cross section analogous to CAD software. The model in the interactive picture can also be scaled and rendered with variable types of light, colour of the background can be changed and assemblies can be exploded or

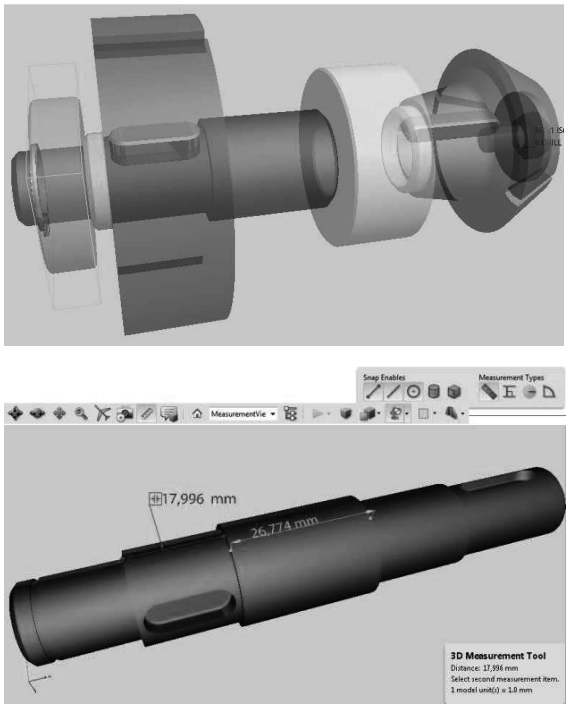

Fig. 4 Virtual assembly in electronic textbook

unexploded. The example of virtual 3D assembly inputted into electronic textbook and dimensions measurement at one of the assembly components are shown in Figure 4. Another advantage of modern electronic lecture note consists in the opportunity to use video-sections (e. g. in *.avi or *.mpeg formats).

3. CONCLUSIONS

The development of technologies in the industry has brought a new thinking of designers. They use more and more possibilities of virtual visualization as a tool for successful suggestion of manufacturing processes in its all stages. This fact influences the requirements for knowledge level of graduate students and forces universities to adapt their study programs to the new conditions of real practice. Education at technical schools should reflect the needs of the job market focused not only on current computer skills (working with text editors, table and database processors), but students should learn to work with basic available CAD/CAM software. Teachers prepare the intending engineers to be able to use the computers in design of technological devices or processes and to be successful at their job interviews. In despite of the fact that working out and understanding of theoretical basis is essential assumptions of education in today conditions, the classical approaches should be update and adapt to the actual trends.

4. ACKNOWLEDGEMENTS

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Thread Inspired 3D Printed Clamps for in vitro Biomechanical Testing

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Abstract

In recent biomechanical testing of soft tissues, many researchers have presented the usage of different clamping techniques such as using frozen clamps, non-frozen serrated jaw clamps, a non-frozen clamp which has lateral block boards and asymmetrical teeth yaws in order to prevent tissues from slipping and without damaging it at high loads. In this study, for the purpose of future biomechanical testing of human gracilis and quadriceps tendons, we present the usage of a 3D printing approach as a possibility for making clamps. We took the measures of the existing pneumatic jaw clamps on Shimadzu AGS-X 10 kN machine and according to the measurements, we have designed and 3D print the clamps which have different geometry inspired by cross-sectional view of metric, trapezoidal and buttress thread, to act as extensions to existing ones and to be able to prevent tendon slipping and damaging during compression. Based on the tensile tests using porcine tendons, we report our experience. It has been shown that we can avoid expensive changes in existing equipment, buying commercially available plastic and metal materials and manufacturing it or else use frozen clamps which are complex and expensive. We have shown that using a low-cost 3D printer and cheap polyethylene terephthalate glycol (PET-G) material can lead to successful scientific work. To our knowledge, by searching an available literature, there is only one similar study published during writing this paper.

Keywords: biomechanical testing, 3d printed clamp, superficial flexor tendon, thread

1. INTRODUCTION

Because of soft tissue viscoelastic characteristics and low friction between the clamp material and wet soft tissues, it is difficult to hold them rigidly at in vitro loads and loading speed. Excessive compression on the soft tissue will elevate stress around the contact area, which leads to rupture before target loads are achieved, too little compression will result in slippage [1]. First succesful attempt to prevent above-metioned problems was solved with „cryo-jaw“ clamp presented in 1982. by Remersa and Schamhardt [2]. They use clamps made of brass which can be connected together with four M8 screws to commpress the tendon ends and then freezing with circulating liquid carbon dioxide. Sharkey et al. [3] have applied similar method on quadriceps and Achilles tendons without slippage and no problems with compression. Shatzmann et al. [4] used water in containment chamber, waited for the water to be frozen and then they proceed with testing of human quadriceps tendon-bone complexes and patellar ligament-bone complexes. Due to complex freezing equipment other researches have reported some different solutions. Cheung and Zhang [5] presented non-frozen serrated yaw clamp made of serrated plastic material. Ng et al. [6] have tested the several gripping methods and evaluated them, including serrated jaw, sandpaper, frozen ends and air-dried ends on 1 kN Shimadzu pneumatic grips and it was found that using the pneumatic grips with cardboard lining the stress concentration at the grip-specimen interface reduced substantially. During writing this paper one similar approach has been published [7]. In that paper authors use quasi-static tensile tests

combined with digital image correlation and fatigue trials characterized the applicability of the clamping technique using 3D printed clamps. They have reported that 3D printed clamps showed no signs of clamping-related failure during the quasi-static tests and in the fatigue tests, material slippage was low, allowing for cyclic tests beyond 10^5 cycles. Comparison to other clamping techniques yields that 3D printed clamps ease and expedite specimen handling, are highly adaptable to specimen geometries and ideal for high-standardization and high-throughput experiments in soft tissue biomechanics. They used clamp design with 4-sided pyramid structures in cross-sectional view. For all 3D prints, the parts were produced with 100-micron layers using a 0,4 mm brass nozzle. The clamps were printed in an upright position for a lateral orientation of the pyramids, allowing a very detailed quality of these surface structures. The material used for 3D printing of clamps was polylactic acid (PLA). In this study, we report our preliminary experience using 3D printing technique for the purpose of the future biomechanical tests of human gracilis and quadriceps tendons. This approach is based on the analysing and measuring of the parts of the existing equipment, 3D modelling, 3D printing, mounting on the machine, testing and validation. All parts of the approach will be discussed.

2. METHODS AND MATERIALS USED FOR RESEARCH

2.1. Analysis and measurement of 10 kN Shimadzu pneumatic grips

After reassembling the lower pneumatic grip as shown in Figure 1, from the 10 kN Shimadzu tensile test machine, we proceed with analysis and measurement of grip parts. It has been determined that clamps have next properties: 40x60x10 mm, two holes with M4x1 mm internal thread, 4 mm deep, while the hole is 7 mm deep. The middle hole is 16 mm in diameter and 4 mm deep. Figure 2 shows all the other properties. The same procedure has been done for the upper pneumatic grip and clamps. We also have to take care of a space between the two pneumatic clamps to see how much space do we have for 3D printed clamps.

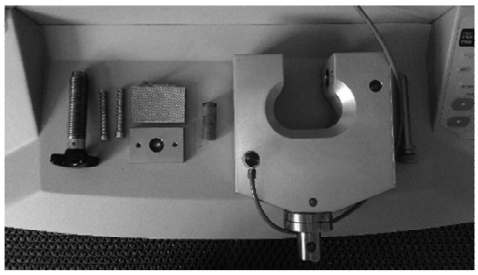

Fig. 1. Parts of the lower pneumatic grip

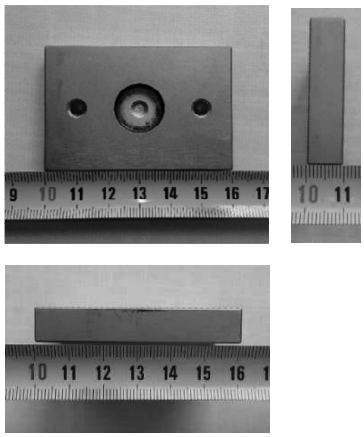

Fig. 2. Orthogonal projections

2.2. 3D model of clamps

When we look at the side view of the clamp, we considered it as a cross-sectional view of a one half of a bolt, which means that the clamp thickness of 10 mm represents one half of a bolt. If we add the additional material, in this case, PET-G clamps, the thickness will rise. To conclude, we act like we have a bolt which has 40 mm in diameter and according to that, we have to choose appropriate metric M42x4,5 mm (M40 is not listed into a group of normal metric threads by the literature), trapezoidal Tr40x3mm and buttress S40x3mm external thread according to DIN 103. Therefore, using SolidWorks 2016, we put the “bolt” axis on one side of the clamp and on the other we have added thread profile. This procedure is shown in Figure 3 and an example of the complete 3D model in Figure 4. For the purpose of 3D printing, all models were exported as a *.stl* file.

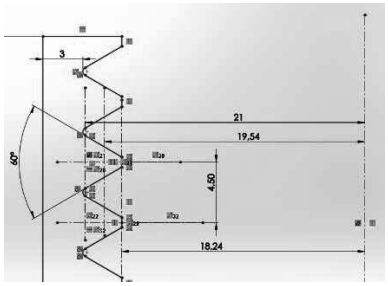

Fig. 3. Metric thread design

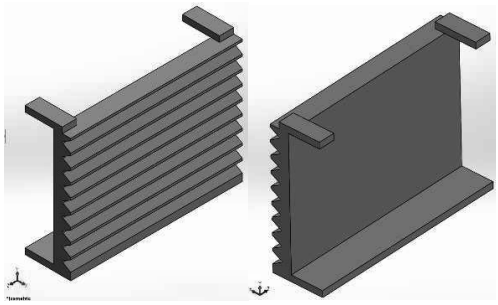

Fig. 4. 3D model of clamps (front and back isometric view)-metric thread

2.3. 3D printing and mounting

All models were processed with the Ultimaker Cura 3.4.1 slicing application prior to printing and Creality Ender-2 3D printer was used. All models were printed in the upright position with polyethylene terephthalate glycol (PET-G) commercially available biodegradable material with 200-micron layers and 0,4mm brass nozzle, Figure 5. The temperature of the nozzle was set to 225 °C and 60 °C for the bed. Figure 5 shows the example of a 3D printed clamp with a buttress thread during the printing process.

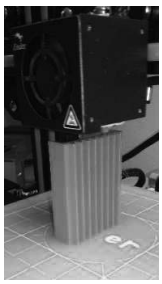

Fig. 5. Clamp during printing with buttress thread design

Next step was mounting 3D printed clamps on the pneumatic grips, which is shown here in Figure 6.

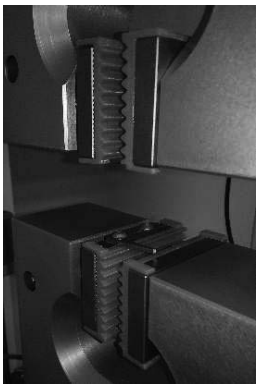

Fig. 6. Mounted clamps

2.4. Biomechanical tests

Forty-two porcine superficial flexor tendons were obtained from an abattoir within two hours after sacrifice. After removing all connective tissue, the tendons were finally isolated and stored in airtight plastic bags and put in the freezer at -20 °C. Prior to testing, the specimens were thawed in water while they still left in their plastic bags to avoid contact with the water during the thawing process which has lasted around 30 minutes. Each specimen was dried out with a soft rag to remove surface moisture. 14 specimens were randomly selected for each of the three clamping methods since we have differences in their length and we intentionally do not want to cut them on the same length. In conclusion, we want random test without forcing anything. Seven of them left in its natural shape and seven of them were formed in dog-bone shape per each clamp. To form the dog-bone shape cutting area was marked. Subsequently, five markers were put on the specimen surface, three of them to serve as guide-points for cutting curves and other two for tracking eventual slippage. The procedure is shown in Figure 7 and finally shape in Figure 8.

The same procedure was used for the tendons which were left in their natural shape, of course without dog-bone cutting paths. For each specimen, the length and cross-sectional area were measured 5 times and the mean value was used.

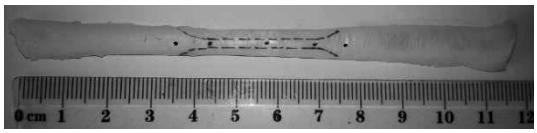

Fig. 7. Markers on the specimen

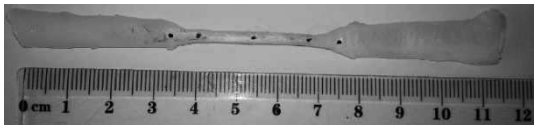

Fig. 8. Final shape of the specimen (dog-bone)

Then the specimens were mounted on the tensile test machine. Gauge length was measured and it was approximately 35 mm long. The pressure applied to the grips were set to 3 bar (720 N clamping force). In order to reduce tissue hysteresis, the specimens were preloaded with a force of 2 N and preconditioned by a series of 10 cycles starting from the undeformed position (0 mm) up to the stroke of 1,5 mm with a stroke rate of 10 mm/min. Five minutes after the preconditioning phase, tendons were tested until their failure. First, they were preloaded with a force of 2 N to remove slack, zero force and movement were established and the test started with 10 mm/min of stroke rate until specimen failure. Example of the experimental setup is presented in Figure 9 with a tendon in its natural form.

The mean values of the ultimate tensile strength (UTS), ultimate stroke strain, and structural modulus were measured. Note that the structural modulus and ultimate stroke strain differ from the actual elastic modulus and ultimate strain of the tendon as they are based on the cross-head motion of the grips. However, for relative comparison between different grips, these can be used [6].

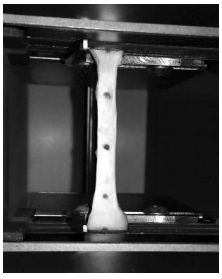

Fig. 9. Setup of the experiment

3. RESULTS AND ACHIEVEMENTS

All presented data have been extracted from the Trapezium X software.

3.1. Trapezoidal clamps

All tests which include dog-bone shaped specimens were finished without slipping and there were no specimen ruptures in the clamping area. Also, all specimens failed in their midd-substance, and an example is shown in Figure 10. Among seven natural shaped specimens, one specimen failed in its midd-substance and three specimens failed at the place where specimen leaves the clamping area. Smith et al. [8] compared the mean ultimate tensile strength of tendons failing at the clamp with the mean ultimate tensile strength of those failing in the mid-substance and found no significant difference between the ultimate tensile strength of ‘clamp failures’ and the ‘mid-failures’. They suggested that the data from clamp failure tests could also be included with data from mid-failure tests [6]. Slippage of 3 mm and rupture in the clamping area occurred in three specimens tested in its natural form, an example is presented in Figure 11. It was excluded from further observations. The recorded mean value of the ultimate tensile strength (UTS) was 50,16±13,51 MPa, ultimate stroke strain 30,04±6,10 % and structural modulus 254,73±68,24 MPa. Results for the naturally shaped specimens were as follows, the mean value of ultimate tensile strength (UTS) was 34,78±9,11 MPa, ultimate stroke strain 32,29±7,57 % and structural modulus 160,31±50,94 MPa. It can be noticed that the difference of 30,66 % is between ultimate tensile strengths, 7,49 % between ultimate stroke strains, and 37,06 % between structural modulus results. Results are also presented below on Figures 12 and 13. Typical tendon tensile test curves and the last tenth cycle of hysteresis are shown in Figures 14, 15, 16 and 17.

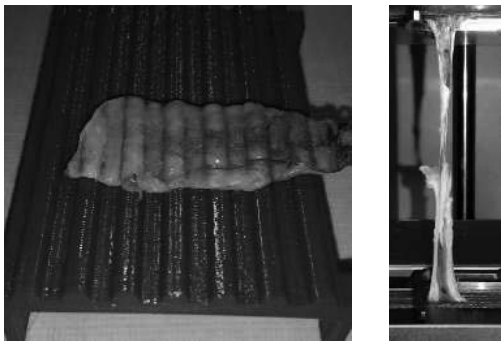

Fig. 10. Clamping are and mid-substance failure of specimen after tensile test

Fig. 11. Slippage of 10 mm and rupture

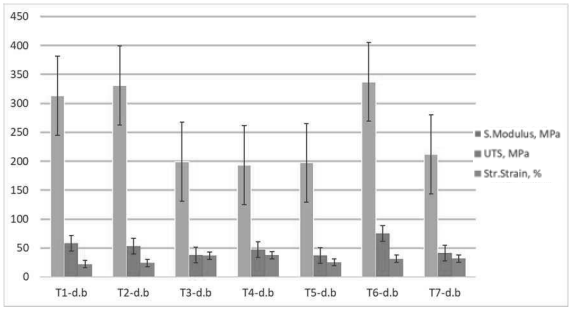

Fig. 12. Results of dog-bone shaped specimen

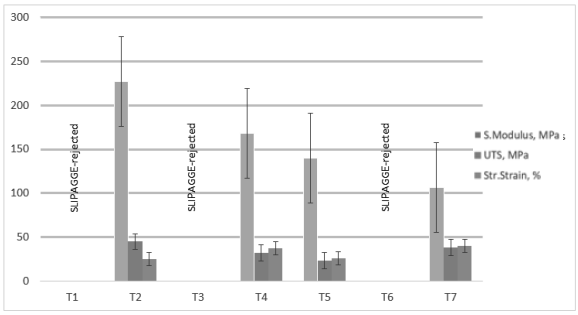

Fig. 13. Results of specimens in their natural form

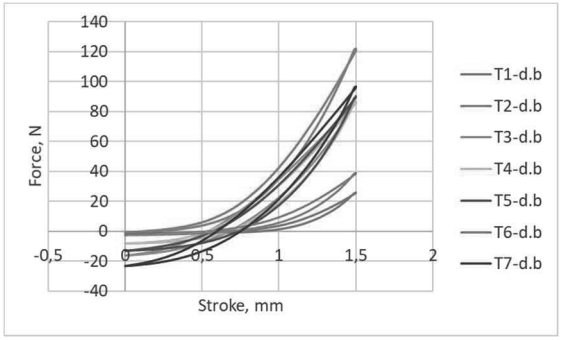

Fig. 14. Hysteresis curves of dog-bone specimens

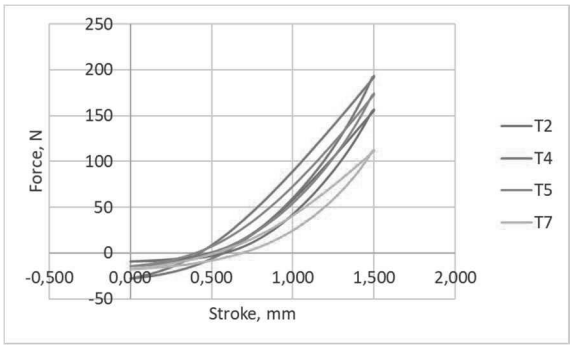

Fig. 15. Hysteresis curves of specimens in natural form (specimens T1, T3, T6 rejected)

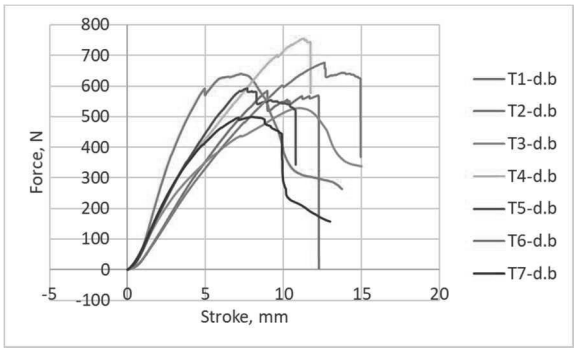

Fig. 16. Tensile tests of dog-bone specimens

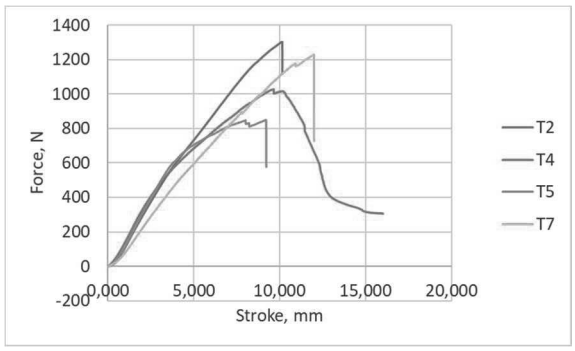

Fig. 17. Tensile tests of specimens in their natural form (specimens T1, T3, T6 rejected)

3.2. Metric clamps

One test of the dog-bone shaped specimen was finished by slipping, three of them were failed in the midd-substance and also three of them at a clamp where tendon leaves the clamping area. There were no specimen ruptures found. Among seven natural shaped specimens, two specimens failed in its midd-substance and three specimens failed at the place where specimen leaves the clamping area. Slipping of 2 mm occurred in two tests without ruptures and they were excluded from analysis.

The recorded mean value of the ultimate tensile strength (UTS) was 41,68±5,39 MPa, ultimate stroke strain 23,74±3,66 % and structural modulus 236,09±66,50 MPa. Results for the naturally shaped specimens were as follows, the mean value of ultimate tensile strength (UTS) was 41,12±6,44 MPa, ultimate stroke strain 22,49±3,31 % and structural modulus 104,98±47,14 MPa. It can be noticed that the difference of 0,86 % is between ultimate tensile strengths, 5,26 % between ultimate stroke strains, and 55,53 % between structural modulus results. Results are also presented below on Figures 18 and 19. Typical tendon tensile test curves and the last tenth cycle of hysteresis are shown in Figures 20, 21, 22 and 23.

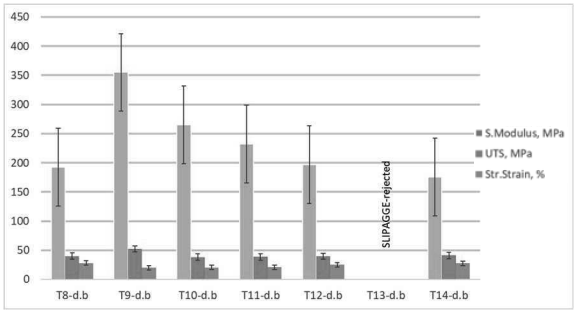

Fig. 18. Results of dog-bone shaped specimen

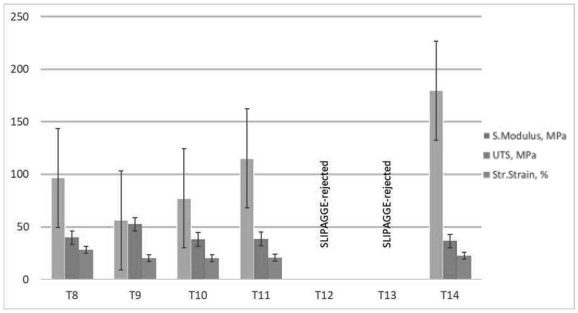

Fig. 19. Results of specimens in their natural form

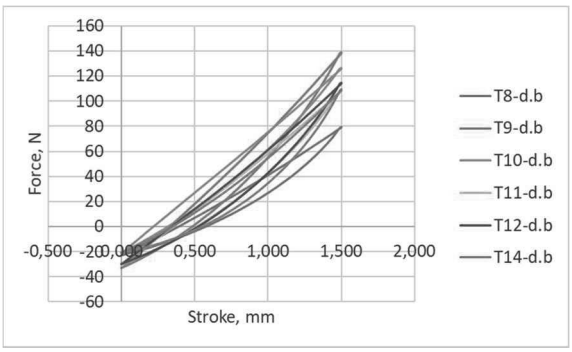

Fig. 20. Hysteresis curves of dog-bone specimens (T13-d.b rejected)

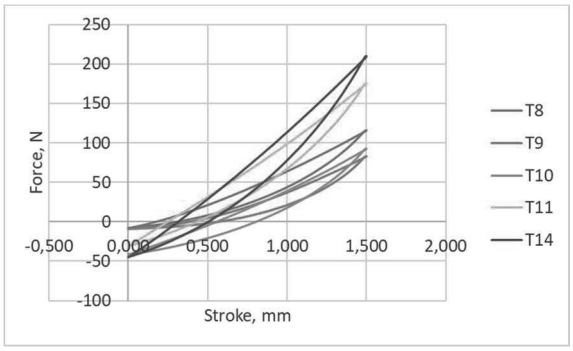

Fig. 21. Hysteresis curves of specimens in natural form (specimens T12, T14 rejected)

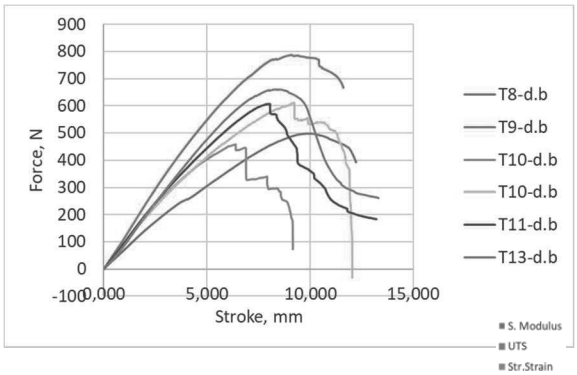

Fig. 22. Tensile tests of dog-bone specimens (T12-d.b rejected)

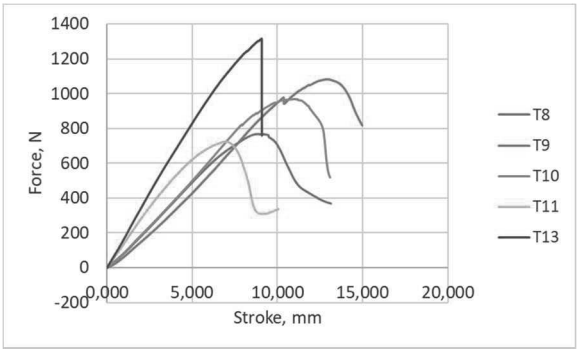

Fig. 23. Tensile tests of specimens in their natural form (specimens T1, T3, T6 rejected)

3.3. Buttress clamps

Among seven dog-bone shaped specimens, one was excluded due to slipping and one because it had bad geometry (cuts caused by imprecise dissection). Four of the specimens failed at its midd-substance and the last one failed at the place were tendon exits the clamping area. Two slipping and rupturing cases in clamping area occurred in two specimens tested in its natural form and they were also excluded from analysis. Slippage was 3 mm long.

The recorded mean value of the ultimate tensile strength (UTS) was 55,73±3,96 MPa, ultimate stroke strain 24,31±3,96 % and structural modulus 304,62±48,92 MPa. Results for the naturally shaped specimens were as follows, the mean value of ultimate tensile strength (UTS) was 30,75±16,79 MPa, ultimate stroke strain 26,29±2,05 % and structural modulus 108,04±53,81 MPa. It can be noticed that the difference of 44,82 % is between ultimate tensile strengths, 8,14 % between ultimate stroke strains, and 64,53 % between structural modulus results. Results are also presented below on Figures 24 and 25. Typical tendon tensile test curves and the last tenth cycle of hysteresis are shown on Figures 26, 27, 28 and 29.

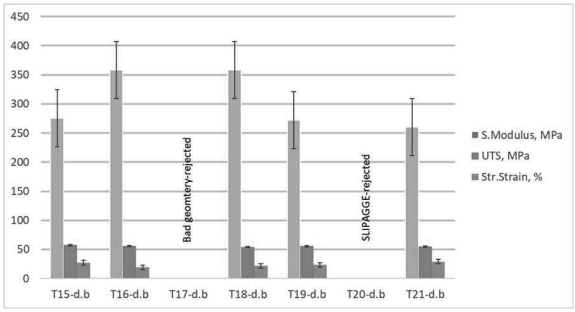

Fig. 24. Results of dog-bone shaped specimen

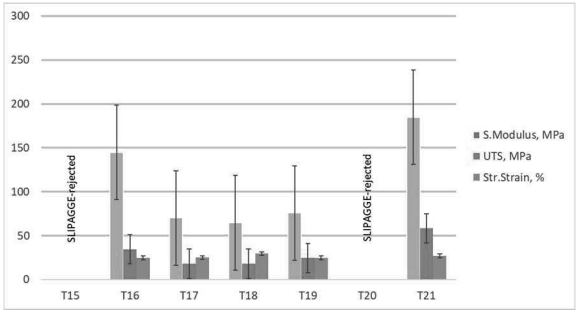

Fig. 25. Results of specimens in their natural form

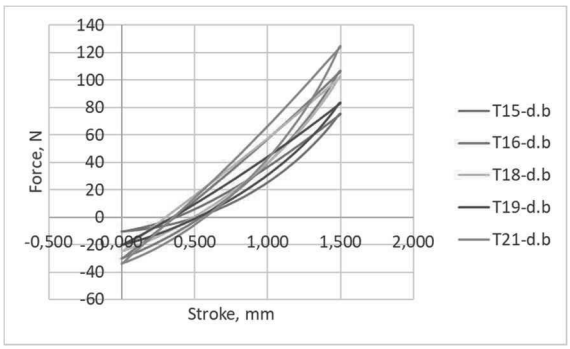

Fig. 26. Hysteresis curves of dog-bone specimens (T17-d.b, T20-d.b rejected)

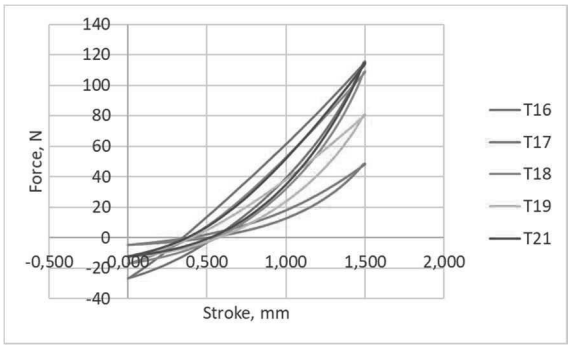

Fig. 27. Hysteresis curves of specimens in natural form (T15, T20 rejected)

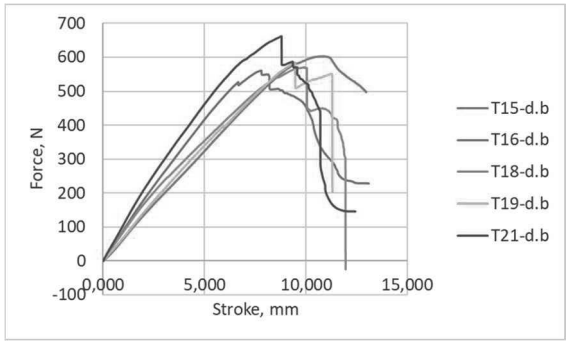

Fig. 28. Tensile tests of dog-bone specimens (T17-d.b, T20-d.b rejected)

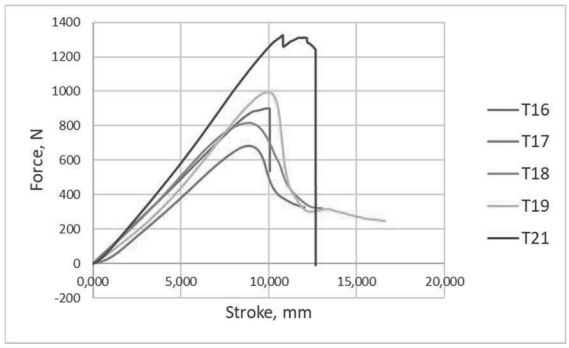

Fig. 29. Tensile tests of specimens in their natural form (specimens T15, T20 rejected)

3.4. Discussion

The average 3D printing time was 2 hours and 15 minutes per clamp. Infill was set to 100%. During printing, we did not have any issues. Clamps fit extremely well at their places on the tensile test machine. The only problem that we had was the easily horizontal movement which causes the small problem during mounting of specimens. During writing this paper, one similar approach was published and it was shortly described above in the introduction, we will consider their approach and find something suitable solution for our mounting problem. We

choose to use the clamping pressure of 3 bar and it shows good clamping behaviour during tests and we found no damage after all. In the [7] they used 6 bar. Maybe we should consider the bigger amount of pressure for the future tests to totally reduce slipping but it could result in higher stress concentrations in tendons tissue and more ruptures in clamping area as well. After all, we did not find any damage in the clamping area or at any other place over the clamps, which indicates that they are very reusable.

Tendons length average was 90 mm, thickness average was 4 mm and width average was 8 mm with an elliptical shape of the cross-sectional area. For the purpose of testing of tendons in their natural form, we had assumed that we have a rectangular cross-sectional area. While creating dog-bone shaped specimen, inspired by sample preparation in [9], in some cases we had problems to achieve well-shaped cross-sectional area, so we should have in mind to use or to create some special tool which could help us with this issue. Still, by searching available literature, there is no clear statement about either to test tendons by creating a dog-bone shape or either to test them in their natural form and also there are no concrete statements about testing protocol. To avoid possible corrosion appearance at our equipment we could not prevent tendons from dehydration by spraying them during tests. We proceed with hysteresis tests and tensile tests. Our rejection term was if a tensile test fails then we will exclude hysteresis results as well. To be clear, we could use them since there is no slippage or rupture because of small loads and displacements but we want 100 % success with tensile tests. We also want to proceed with creep and stress-relaxation tests and fatigue tests as well, but since they are long-lasting tests and since we could not provide tissue moistening, we gave up. Since we have mentioned above disadvantages of this work and the small sample size per one clamp we do not provide any statistical conclusions. But if one may ask us to choose which clamp design could be better to use among others, we will recommend trapezium clamps for samples with dog-bone shaped tendons and then clamps with buttress thread. By our experience, the metrical clamps should be used only for testing tendons in their natural form because these are the only clamps at which failure occurred in midd-substance. To conclude, the complete review of average values of tissue properties between types of clamps are given in Figure 30.

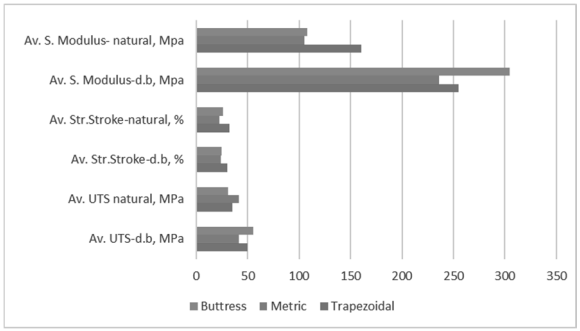

Fig. 30. Average tendon properties and types of clamps

The key advantages of the 3D printed clamps are the ease of use, adaptability, reusability, modularity and the fact that they can be manufactured easily and at local research environments. Furthermore, recent developments in prices, usability and variety of desktop FDM-printers (which was used in this study) allow an easy integration into laboratory environments. Without the maintenance time of the printer, which is often reduced to some minutes (when changing a filament spool or cleaning the build-plate), no additional working time is required for the manufacturing of the parts for testing. Geometries and print settings can be shared easily, forming a basis for affordable add-ons to existing testing devices for tissue biomechanics [7].

Based on this study, in the future, our aim is to develop clamps suitable for the existing equipment and be able to work in special environmental conditions to simulate human body environment and also to avoid above-mentioned slipping and compression problems. We want to provide the standardized, specially designed clamps for the purpose of soft tissue testing. Our future tests will also be based on

porcine tendons and later on human gracilis and quadriceps tendons.

We will involve some additional methods such as digital image correlation, methods to prevent tissue dehydration, etc., to help us in the determination of biomechanical properties which will not be based on cross-head movement and not be classified as structural. We will consider a bigger sample size to provide statistically based conclusions. Also, we will try some different clamp pattern instead of thread design based clamps and a different material such as polylactic acid (PLA) or thermoplastic polyurethane (TPU).

4. ACKNOWLEDGEMENT

The authors acknowledge the support of local slautherhouse Bebrinka d.o.o for the donation of porcine tendons, specially to Ivica Mirković, head of the slautherhouse and to Slavica Baboselac, technologist at the slautherhouse.

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Structural Analysis and Optimization of the Doors on the Falns Freight Wagon

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Abstract

Modern global trends in freight transport demand removal of all unnecessary freight wagon components in order to reduce mass. Because of that, the idea of structural analysis and optimization of the doors on the Falns freight wagon was born. By removing unnecessary mechanism, the mass of the Falns 48 wagon could be reduced by 276 kg, but the maximum deformation of the doors lower edges would increase from 0.04 mm to 3.76 mm. This increase in the maximum deformation of the wagon doors lower edges can cause the cargo to leak out of the wagon and fall down on the rails, and that is strictly forbidden. Therefore, it is necessary to implement optimization to find a certain compromise, or find the optimal solution. The deformations and stresses of the initial constructional solution of the wagon doors, with and without using the additional door holding mechanism, were analysed by using the finite element method. After that, the optimization process was carried out. The aim of the optimization is to reduce the maximum deformation of the doors lower edges at the expense of mass increase. In addition, a new constructional solution for the wagon doors was proposed and optimization of the proposed constructional solution was carried out. By analyzing the results, it was concluded that the use of the additional door holding mechanism on Falns 48 freight wagon, in the case of transporting iron ore, is not justified.

Keywords: Structural analysis, optimization, Falns 48, freight wagon doors finite element method

1. INTRODUCTION

Transportation of bulk cargo such as coke, iron ore, limestone, sand, etc. can be done in multiple ways, one of which being the rail transport. Many different types of freight wagons operate on railways, and one of them is Falns freight wagon type. There are many different trends coming out in the rail freight transport today, and the trend of reducing the wagon mass by applying better construction solutions and better materials is one of them. Therefore, in order for a company to be successful on the competitive market, investments in developing new construction solutions and improvements of existing solutions are inevitable.

Analysis of deformation and stress using the finite element method of the Falns 48 wagon doors was done as a part of this paper. A new construction solution, for which deformations and stresses have been additionally analysed, are suggested, followed by an optimization of the new construction solution with the overall aim of reducing the deformation of the lower wagon door edge at the expense of increasing the mass. Falns 48 wagon is intended for iron ore transportation.

Therefore, at first, the aim was to answer a very simple question: “Is it justified to use the mechanism for additional door holding on the Falns 48 wagon doors?”

If the use of the mechanism for additional door holding on the Falns 48 wagon doors proves not to be justified, that would mean that the mechanism could be removed from the wagon. This would mean that the mass of the wagon would be reduced by 276 kg and consequently 276 kg of cargo more could be transported by the wagon.

Fig. 1. Doors and mechanism for additional door holding on wagon type Falns 48

2. METHODS AND MATERIALS USED FOR RESEARCH

The analysis of deformation and stress was conducted by using solid (*SOLID186*), shell (*SHELL181*) elements with and without midside nodes, as well as solid-shell (*SOLSH190*) finite elements. The four methods were used with the aim of checking and comparing the received results [1]. The wagon door construction was optimized by using the response surface method, that is, by using central composite design [2, 3, 4]. The structural analysis and optimization were conducted by using *Ansys 17.2* computer software.

2.1. Behaviour of soils and fluids

The soils are, by their behaviour, between solids and liquids. If there is no significant normal stress, the soils cannot transmit bigger shear stresses. The distribution of the hydrostatic pressure within fluids can be described by using the Pascal’s law, and the state of stress within soils can be described by using a mechanics of materials equations. Soil mechanics equations (Fig. 2.) can be used to describe the state of stress (pressure) within a soil as follows [5]:

$$\sigma_{\mathrm{v}} = \sigma_{\mathrm{z}} = \rho_{\mathrm{r}} \cdot g \cdot z \tag{1}$$

$$\sigma_{\mathrm{h}} = \sigma_{\mathrm{x}} = K_0 \cdot \sigma_{\mathrm{v}} \tag{2}$$

Hereby σ_{v} presents vertical stress component, σ_{h} horizontal stress component, σ_{x} i σ_{z} are stress components in the direction of the x and z-axis, g acceleration of Earth’s gravity, z distance from the referent surface (depth), ρ_{r} bulk density and K_0 coefficient of earth pressure at rest.

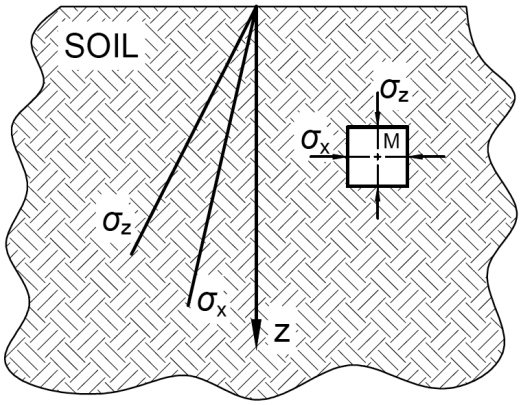


Fig. 2. Vertical and horizontal stress in soil

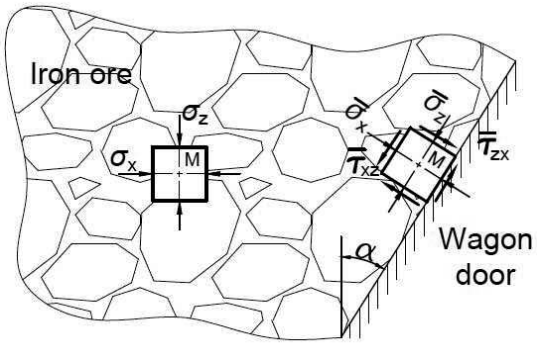


Fig. 3. Illustration of stress tensor transformation

The coefficient of earth pressure at rest is approximately equal to [6]:

$$K_0 \approx 1 - \sin(\phi) \approx \frac{\nu}{1-\nu} \tag{3}$$

Hereby ϕ presents the angle of internal friction, while ν is the Poisson ratio.

In order to determine the pressure against the surface of the wagon doors that are placed under a certain angle α, it is necessary to apply the transformation of stress tensor. In this case, the shear stress component of the transformed stress tensor were not important. That is the reason why the equation for the transformation of the shear stress component tensor was left out. This step is carried out by using the expression for transformation of stress tensor (Fig. 3.) [7]:

$$\bar{\sigma}_{\mathrm{x}} = \frac{\sigma_{\mathrm{x}} + \sigma_{\mathrm{z}}}{2} + \frac{\sigma_{\mathrm{x}} - \sigma_{\mathrm{z}}}{2}\cos(2\alpha) + \tau_{\mathrm{xz}}\sin(2\alpha) \tag{4}$$

$$\bar{\sigma}_{\mathrm{z}} = \frac{\sigma_{\mathrm{x}} + \sigma_{\mathrm{z}}}{2} - \frac{\sigma_{\mathrm{x}} - \sigma_{\mathrm{z}}}{2}\cos(2\alpha) - \tau_{\mathrm{xz}}\sin(2\alpha) \tag{5}$$

After equations (1), (2) and (3) are included in equations (4) and (5) and have been sorted out, the final expressions are as follows:

$$\bar{\sigma}_{\mathrm{x}} = \frac{\rho_{\mathrm{r}} g z}{2}\left[2 - \sin(\phi) - \sin(\phi)\cos(2\alpha)\right] \tag{6}$$

$$\bar{\sigma}_{\mathrm{z}} = \frac{\rho_{\mathrm{r}} g z}{2}\left[2 - \sin(\phi) + \sin(\phi)\cos(2\alpha)\right] \tag{7}$$

2.2. Boundary conditions

In this subchapter, a way of determining the boundary conditions of the limits for displacement on the example of the initial construction solution without the mechanism for additional holding the wagon doors is described.

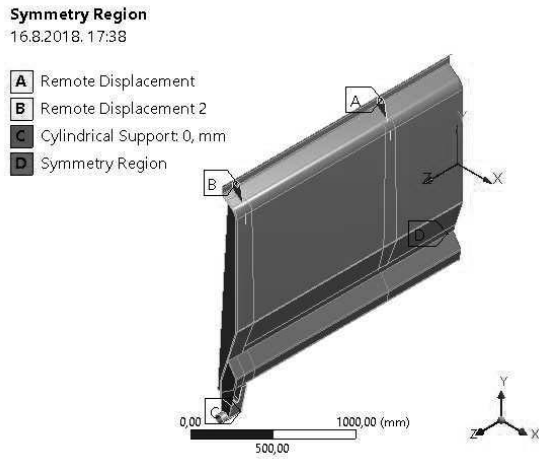


Fig. 4. Boundary conditions

(Fig. 4.). Since the Falns 48 wagon doors are symmetrical, boundary condition of symmetry region was used. This approach decreases computation time for a given mesh, because only one half of the model has been observed.

2.3. Physical properties of iron ore, slight sand and water

Falns 48 wagon doors were created with the original purpose of transporting iron ore. In order to determine the most critical situation in which the irone ore exerts the most pressure, it is neccesarry that the wagon is evenly filled up till the brim of the wagon, and that the mass of the cargo represents the highest possible carrying capacity of the wagon. The biggest carrying capacity of the Falns 48 wagon m_{t} is 68.5 t. The capacity V of the Falns 48 wagon is 48 m^3 which is why the highest iron ore bulk density which whould secure that the wagon is totally filled and the highest mass allowed is reached is as follows:

$$\rho_{\mathrm{r}} = \frac{m_{\mathrm{t}}}{V} = \frac{68500}{48} = 1427.08 \text{ kg/m}^3$$

Therefore, it is assumed that the granulation of the iron ore transported by the Falns 48 wagon would be such that its bulk density equals 1427.08 kg/m^3, and the angle of internal friction ϕ 37° [8].

The chosen bulk density for the slight sand equals 1380 kg/m^3, and the angle of internal friction ϕ is 30° for the roundly shaped particles [9].

In the case that the wagon doors are under water pressure, the chosen water density is 1000 kg/m^3.

2.4 Mechanical properties of Durostat 450 material

For the analysis of the stress and deformation of the initial construction solution for the Falns 48 wagon doors, as well as for the new construction solution for the Falns 48 wagon doors, the same material was used. The material used is a material with the commercial name - *Durostat 450*.

Yield strength of the *Durostat 450* material $R_{p0.2}$ is 1250 MPa, and tensile strength R_m equals 1450 MPa. The chosen elastic modulus *E* is 205 000 MPa [10].

2.5. Hypotheses

Hypotheses as a result of the model studied in this article are as follows:

- Iron ore, slight sand and water inside Falns 48 freight wagon are observed like a continuum,
- The chosen iron ore bulk density is 1427.08 kg/m^3 in order to describe the worst-case scenario, that is the one in which the wagon is filled up till the brim and maximum capacity is reached.

2.6 Input and output parameters used for optimization

The input parameters chosen for optimization are different for each wagon construction solution. The relevant input parameters were determined based on the Spearman's rank order correlation and correlation matrix. Thickness of individual wagon door panels present the input parameters. Output parameters are deformation of the lower door edge and the mass.

The goal was, therefore, to find a solution which will have the smallest deformation of the lower door edge while the doors would be of the smallest mass possible.

Optimization was created on the basis of results received from the shell elements with midside nodes.

3. RESULTS OF STRUCTURAL ANALYSIS AND OPTIMIZATION

In this chapter, the main emphasis is on the results of the deformation of the lower door edge. The results of the deformation of the lower door edge are key elements in order to reach conclusion on whether the use of the mechanism for additional door holding is justified.

3.1. Deformations and stresses

Figure 5 shows the field of equivalent stresses of the initial construction solution without the use of the mechanism for additional door holding. The equivalent stresses do not go over the yield strength of the material. The door deformation field (Fig. 6.) and the deformation of the lower door edge (Fig. 7.) are visually presented as well. All three visually presented results are connected with the analysis of the shell elements without midside nodes. The mesh consists of 168 774 nodes, or 56 567 elements. The average skewness is 0.03 and the maximum skewness is approximately equal to 0.913. This mesh has poorer quality than the mesh obtained with shell elements without midside nodes, but it is still satisfactory. One of the reasons being that some larger elements have been used here. However, this does not have a significant impact on the deformation field.

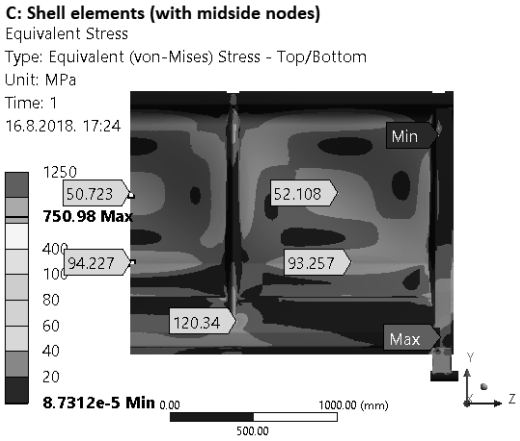


Fig. 5. Equivalent stress – shell elements with midside nodes

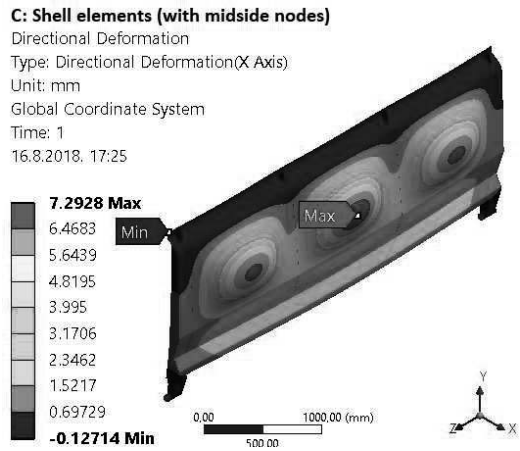


Fig. 6. Directional deformation

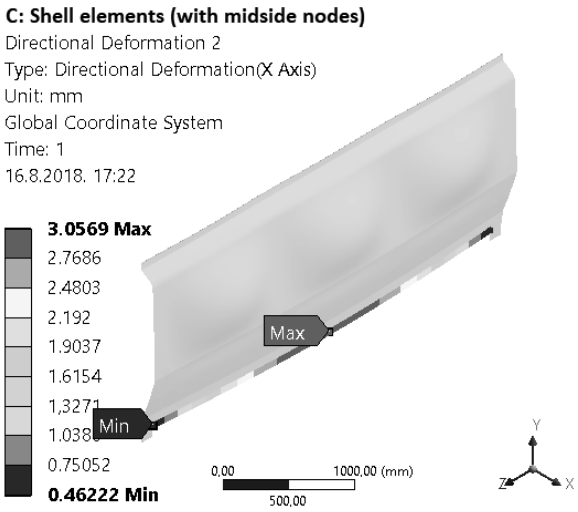
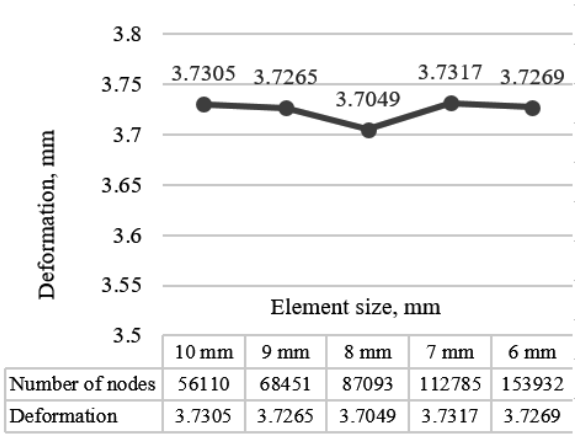


Fig. 7. Directional deformation of the door's lower edge

3.2. Deformation convergence

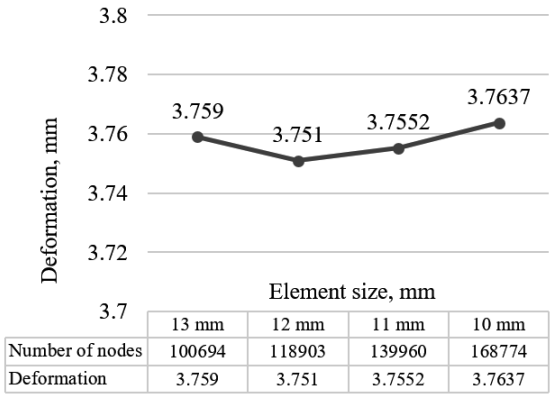
Deformation convergence of the lower door edge (Fig. 8., Fig. 9. and Fig. 10.) is presented on the example of the analysis of the initial wagon door construction without using the mechanism for the additional door holding. The chosen shell elements without midside nodes size is 6 mm, 10 mm of the shell elements with midside nodes, 8 mm of solid elements and 8 mm of solid - shell elements (Fig. 11.).



	10 mm	9 mm	8 mm	7 mm	6 mm
Number of nodes	56110	68451	87093	112785	153932
Deformation	3.7305	3.7265	3.7049	3.7317	3.7269

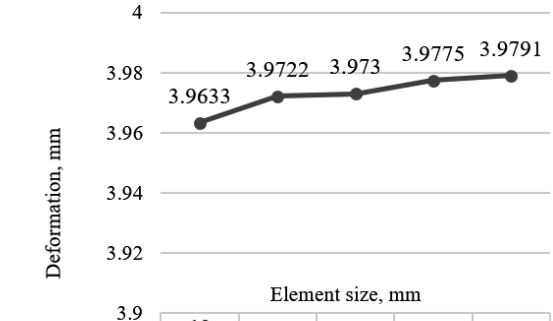
Fig. 8. Shell elements without midside nodes

The deformation value received with the shell elements with midside nodes was chosen as the refenet value. The percentages above the columns (Fig. 11.) represent the deviations of the single displacement results from the referent value.



	13 mm	12 mm	11 mm	10 mm
Number of nodes	100694	118903	139960	168774
Deformation	3.759	3.751	3.7552	3.7637

Fig. 9. Shell elements with midside nodes



	10 mm	9 mm	8 mm	7 mm	6 mm
Number of nodes	425500	519110	657586	848151	1147504
Deformation	3.9633	3.9722	3.973	3.9775	3.9791

Fig. 10. Solid elements

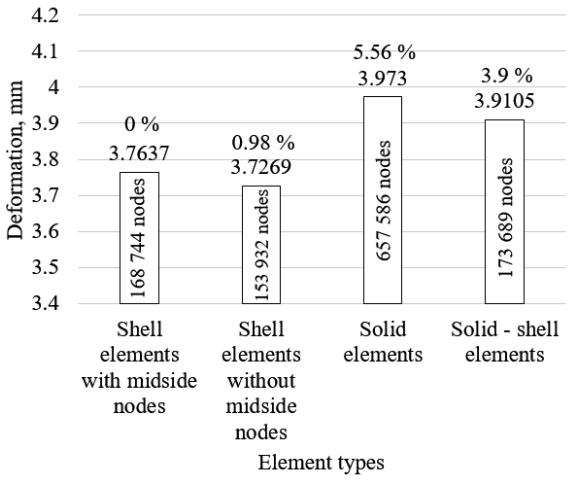


Fig. 11. Directional deformation comparison of the door's lower edges

3.3. Comparison of obtained results

The initial construction door solution has a mass of 442.6 kg. If the doors are additionally held with the mechanism for additional holding, then the maximal deformation of the lower door edge equals 0.04 mm. However, if the mechanism for additional holding is removed,

then the maximal deformation of the lower door edge is in the middle of the edge and equals approximately 3.76 mm. With additional optimization and redesign of the doors, it is possible to reduce the deformation of the lower door edge, but that would result in increase of the door mass (Tab. 1.).

Tab. 1. Deformations and masses of the doors for iron ore as observed cargo

	Mass of the door, kg	Total mass reduction of the wagon, kg	Max. deformation of the door's lower edge, mm
Initial design of the doors before optimization, with mechanism for additional door holding	442.6	0	0.04
Initial design of the doors before optimization, without mechanism	442.6	276	3.7637
Initial design of the doors after optimization, without mechanism	494.82	68.72	3.0538
New design of the doors before optimization, without mechanism	448.98	250.48	3.4687
New design of the doors after optimization, without mechanism	509.56	9.76	2.7837

Even though the original purpose of the Falns 48 wagon is to transport iron ore, there is a possibility for it to be used for transportation of other kinds of bulk goods (e.g. sand). Therefore, the results of lower door edge deformation have been compared for the cases in which the wagon would be transporting iron ore, sand and water. The results of lower door edge deformation refer to the initial construction door solution without the mechanism for additional door holding. (Tab. 2.)

Tab. 2. Max. deformations of the Door's lower edges for different load types (without mechanism for additional door holding)

Load types	Bulk density, kg/m^3	Angle of internal friction, °	Deformations of door's lower edges, mm
Iron ore	1427.08	37	3.7637
Slight sand	1380	30	4.3629
Water	1000	-	5.822

4. CONCLUSIONS

After analysis and optimization of the initial and the new Falns 48 wagon door construction solution have been conducted, it can be concluded that the use of the mechanism for the additional holding of the Falns 48 wagon doors for transportation of iron ore is not justified. However, if the user decides to use the wagon for the purpose of transporting sand – the use of mechanism for the additional door holding is justified.

If the granulation of the smallest particles is bigger than 2.8 mm in the case of static load of the wagon, then, according to the results of this analysis, there should not be any outpouring of the particles from the wagon.

During further development and improvement of the new construction solution, the possibility of additional sealing by using steel sealing elements should be considered. In order to achieve additional sealing of the doors, it is proposed to overly tension the bolts, or to add properly shaped sealing elements on the lower door edge.

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Machine Overlay Welding of Single Tubes

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Abstract

The paper describes the most frequent nickle alloy overlay welding procedures in protection of boilers as well as automated overlay welding machine. In most cases, long overlay welding is done on machines. Describes the basic pieces of equipment, as well as the principle of their work. The experimental part includes the overlay welding for the qualification of the welding process on the machine for single tubes in protection of four-component and two-component gas, and comparison of the obtained results.

Keywords: nickle alloy, overlay welding machine, qualification of the welding process

1. INTRODUCTION

Today, due to the constant increase in the number of inhabitants in the world and the cities, the growth of industry and living standards is the problem of increasing electricity consumption (Fig. 1.). Increasing the population by itself raises the problem of increasing the amount of waste that needs to be properly disposed or destroyed. Because of the rising energy prices we get from traditional sources but also because of the more stringent environmental protection measures, people are forced to use solid waste to get energy. One of the solutions to the problem is the possibility of incinerating municipal waste or the use of waste as a fuel in thermal power plants for obtaining electricity and heat.

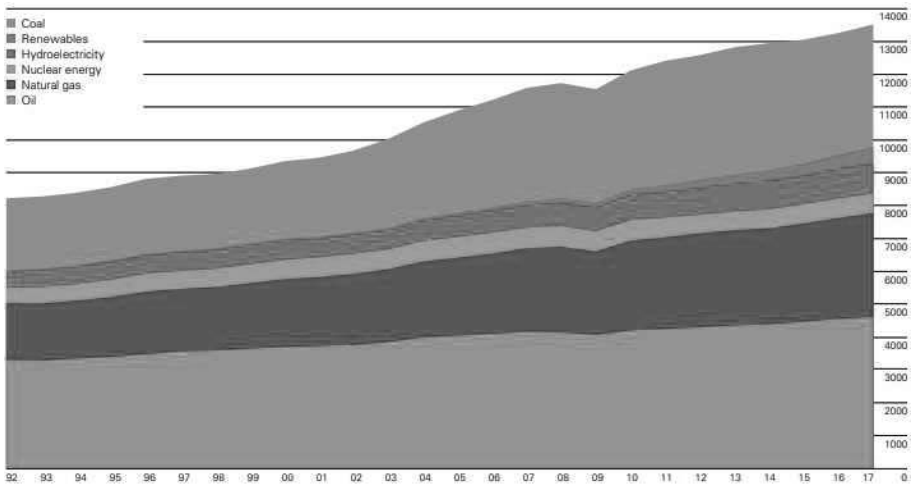

Fig. 1. Energy consumption trend [1]

2. OVERLAY WELDING IN BOILER CONSTRUCTION

The overlay welding is the procedure of electro welding by melting and applying additional material on the surface of the base material in order to achieve the desired properties, dimensions and shapes. [2]

Hard facing is the application of a hard material resistant to wear by a welding process. Most commonly used materials for corrosion resistance are carbon-based steels and low-alloyed steels with low carbon content, but more and more are required for high-density martensitic steels.

Very high temperatures and chemical reactions arising from combustion of fuel in the boiler furnace are among the biggest steel enemies. The most corrosive parts of the boiler furnace are membrane tubular walls which are directly affected by flue gas, soot and products of combustion, as well as overhead water vapour on which soot deposits are formed. There are a number of inconvenient chemical reactions in the combustion of fuel that produce layers of impurities that favour the formation of high temperature corrosion on the steel. [3]

Fig. 2. The overlay welded opening of the membrane wall

The overlay welding in the boiler is performed with MIG / MAG, TIG and MMA procedures, and MAG process is most prominent because of its economy and simplicity. Enormous use in the boom has mechanical and automated threading processes that contribute to economic cost-effectiveness.

2.1. Description of the machine for single tube overlay welding

The automated MAG process has a mechanized wire lead in the electric arc and mechanized conduction of the welding torch. In the boiler construction, this welding procedure is applied for overlay welding of the single tubes of the membrane walls, connecting pipes, heating surfaces and the headers of membrane walls (Fig. 3.).

The welding source is a classic TPS source (Trans Pulls Synergic 5000i) with wire feeders. The welding machine consists of two sources each having one welding torch. Torches makes linear motion over the tubes length while the tube is rotated. Other parts include sliding guides, rigid drive positioners, cab displacement motors and welding torches, operator cab, control cabinet, process cooling system, gas supply system, and an additional material transport system. [4]

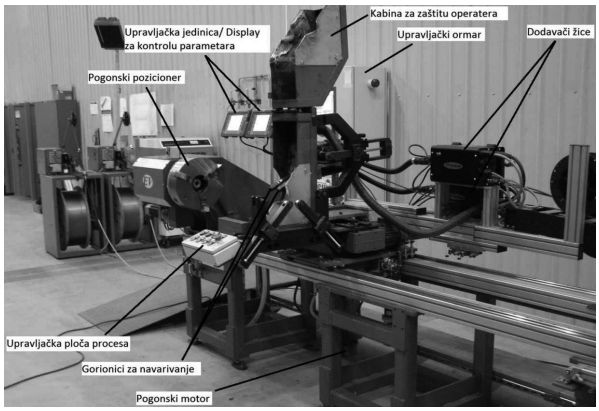

Fig. 3. Automat for single tubes overlay welding

2.2. Filler material for overlay welding (625 Ni Alloy)

Nickel alloy alloy SNi 6625 according to EN ISO 18274 (NiCr22Mo9Nb), commercially known as Thermanit 625, is used as an filler material in the process of overlay welding of single tubes on the membrane walls. The content of iron in the filler material should not exceed 0.5% (Table 1).

The property of nickel-alloy (W.Nr. 2.4856) is high strength, corrosion resistance and elevated temperature. This combination of chemical elements provides high resistance to corrosive environments in the boiler combustion using waste as a fuel to the influence of high temperatures that cause oxidation and carbonization of the metal. [2]

Table 1. Chemical composition of 625 filler material [5]

Chemical element	%
Ni	Min 58,0
Cr	20,0÷23,0
Fe	Max 0,5
Mo	8,0÷10,0
Ni+Ta	3,15÷4,15
C	Max 0,10
Ma	Max 0,50
Si	Max 0,50
F	Max 0,015
S	Max 0,015
Al	Max 0,40
Ti	Max 0,40
Co	Max 1,0

2.3. Preparing the surface before overlay welding

The surface of the tubes before overlay welding is metal blasting with metal scrap to remove surface impurities and residual corrosion resulting from storage. After metal blasting surface of the tube, it is grinded to metallic gloss on a moderately rough surface. Figure 4. shows the non-grinded and grinded tube. The picture shows the difference in the visual appearance and roughness of the tube.

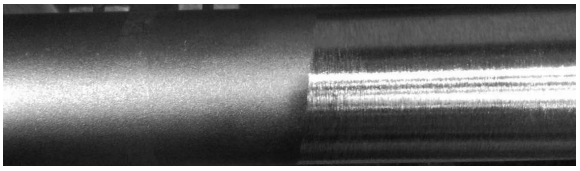

Fig. 4. Surface of grinded and non-grinded tube

3. THE EXPERIMENTAL PART OF THE OVERLAY WELDING

The experimental part of the overlay welding is carried out on samples in the protection of a four-component and two-component mixture of gases. Two samples were welded with the 4-component gas mixture of the factory name Cronigon Ni10 (30% He + 2% H2CO2 + Ar) and two samples with a two-component gas mixture of Inoxline C2 (97.5% Ar + 2.5% CO2).

Given the high cost of a four-component gas, solely helium, the goal is make welding in protect of two-component gas, and reduce costs by eliminating protective gas helium. In order to reduce the cost of overlay welding, two-component gas protection (97.5% Ar + 2.5% CO2) and a comparison of the results obtained with a four-component mixture were accessed. The filler material is used Thermanit 625, 1.2 mm in diameter, and batch 103488. Due to the requirements of a minimum 5% Fe content on the surface of the layer, it is necessary to provide a minimum mixing of the basic and filler material and again to achieve sufficient bonding to avoid lack of fusion. The welding was performed in parallel in two layers with two burners. The burner positions are shown in Figure 5.

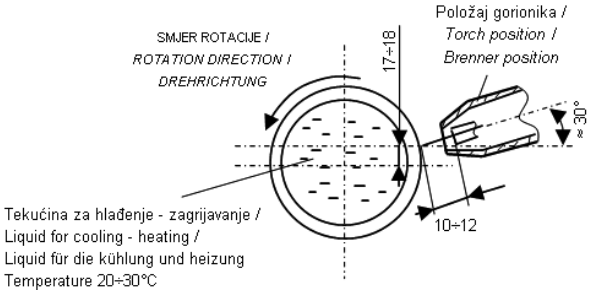

Fig. 5. Position and direction of rotation of single tubes

3.1. Observations during overlay welding

After welding the tube has no deformation because the overlay welding is circular and the heat input is evenly distributed over the tube. Before starting the overlay, we must take care of the necessary length because the shrinkage of tube (heat input).

Four component gas mixture (Ar + 30% He + 2% H2CO2): (a good spreading of metal bath, optimal overlay speed, optimal welding current, the smooth surface, glossy surface)

A two-component mixture (97.5% Ar + 2.5% CO2): (Weaker spreading of metal bath, decrease the overlay speed, Reduction of welding current, rough surface, unstable electric arc, the unnatural dark colour of the overlay)

3.2. Visual comparation of sample

Comparing Figures 6 and 7, there is a difference in the visual quality of the overlay. Sampled in two-component gas protection from Figure 6, the surface of the overlay is black with a poor spreading. The surface is rough and aesthetically bad. The sample in the four-component gas protection of Figure 7 is a light colour with excellent smooth surface. The surface quality is exceptionally good. Figure 8 shows the places where measurements of hardness and Fe content were made.

From figure 9 we can see that the measurements were made on the first layer (measurements 6 to 10) and after the second layer (measurements 1 to 5). The Fe content on the surface on the booth samples is in the required limits. On the samples referred to in the two component gas mixture, the Fe content is at the upper limit of admissibility (~ 4%), while the content of Fe-a on samples welded in protection the four-component gas already in the

Fig. 6. Sample overlay welded in protection of two-component gas mixture

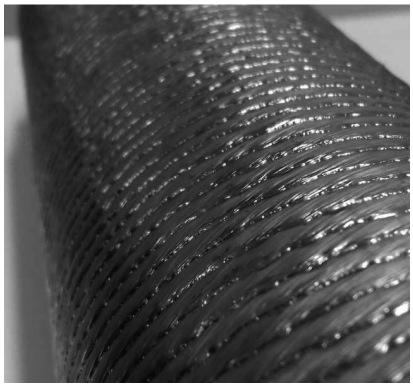

Fig. 7. Sample overlay welded in protection of four-component gas mixture

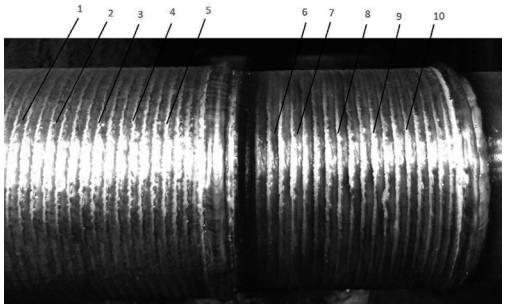

Fig. 8 Area of measurement

first layer is less than 4%.

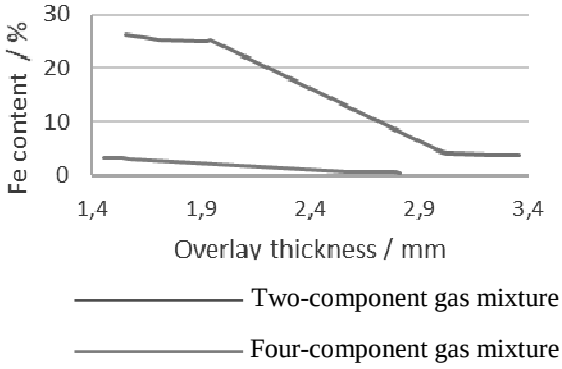

Fig. 9 Measured values of the thickness and the Fe content of overlay

The average overlay thickness on samples welded in protection of the four-component gas mixture is smaller than the samples in protection of the two component gas.

Samples welded in protection of the two-component gas mixture have a higher thickness well as increased iron content on the surface of the overlay in both layers.

By analysing the hardness values for samples we can conclude that the values do not deviate too much by changing the protective gas as can be seen in Figure 10.

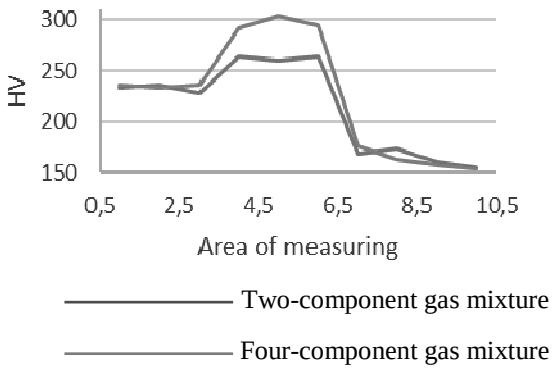

Fig. 10 Measured values of the thickness and the hardness values

4. CONCLUSIONS

Comparison of the obtained results, parallel samples are used welding in protection of the two-component and four-component gas mixture. The results obtained differ depending on the test and the used gas. The results obtained on the single tube automation system meet the required criteria for the surface thickness and Fe content of the surface, while the visual state of the surface of the samples of two-component gas protection is significantly lower than the four-component mixture of gases. By changing the protective gas, it is not possible to achieve a visually high quality of the layer while retaining the existing welding speeds. As a result of retaining the welding speed, we have open porosity on the surface. With the reduction of the speed, we have a thicker layer with a conditional good bonding and a visual appearance of the dark-coloured surface. By comparing the results of the thickness and the content of Fe, depending on the protective gas, we can conclude that overlay welding in the protection of two-component gases has an increased thickness of the overlay and an increased iron content at the surface. For samples welded in the protection of a 4-component gas mixture, Fe content is already below the required limit on the first layer, and we can conclude that it is suitable for thickening lover than 2mm thickness, which is more and more frequent to customer requirements.

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Eyebrows Mechanism with 2 DOFs for Expressing Nonverbal Communication of Socially Interactive Robots

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Abstract

Although socially interactive robots are not human beings, they are expected to realize human-like communication, verbal and nonverbal. The face is the most expressive part of the body, where the nonverbal communication is realized in an intuitive and transparent manner. By activating the characteristic facial parts – eyebrows, eyes and mouth, robots can express numerous emotions, such as surprises, happiness, sadness, anger, etc. For this reason, special attention was paid to the eyebrows and their structure. The paper presents an eyebrows mechanism for the expression of nonverbal communication of socially interactive robots. Based on the set requirements, an eyebrows linkage mechanism with 2 DOFs is proposed. It consists of a 6-bar piston mechanism that allows the rotation of both eyebrows simultaneously, and a 2-bar linkage mechanism for lifting both eyebrows at the same time. It is also possible to combine these two movements. By kinematic analysis the basic parameters of the mechanisms are defined. The mechanisms are simple structures and have small strokes and dimensions.

Keywords: socially interactive robot, nonverbal communication, eyebrows mechanism, kinematic analysis

1. INTRODUCTION

For the successful operation of socially interactive robots in a human's immediate and everyday environment, the interaction between human and robot is essential. In addition to verbal communication, social robots must be able to realize nonverbal communication, which expresses numerous emotions in a natural and transparent manner. There are several generally accepted ways to realize nonverbal communication of robots, such as facial expressions, gestures, shoulder shrugs, nodding etc. However, facial expressions are the most powerful means for generating emotions, which makes them one of the main features of socially interactive robots. It should be noted that in the previous decade significant research efforts were made in the development and realization of interactive elements of the robot.

Figure 1 shows a typical example of a social robot whose name is iCat – an interactive cat, which is able to communicate with the user in a simple and intuitive manner, both verbally and nonverbally. Verbal communication is accompanied by an appropriate intonation that emphasizes the meaning of spoken words. For realizing nonverbal communication, the robot has 2 DOFs neck, 2 DOFs eyebrows, 2 DOFs eyelids, 3 DOFs eyeballs and 4 DOFs mouth, which is a total of 13 DOFs. By moving the head and activating the characteristic parts of the face, the robot is able to express happiness, sadness, anger, surprise, fear etc.

The paper presents 2 DOFs eyebrows mechanism, as an addition to the assortment for the expression of nonverbal communication of socially interactive robots by way of their face.

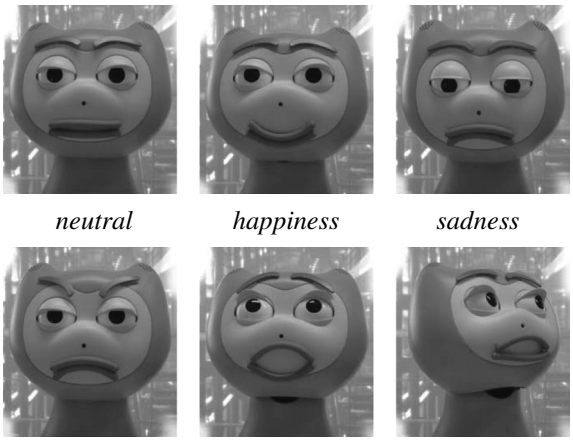

Fig. 1. The iCat's facial expressions [1]

2. STATE OF THE ART

Based on the available literature review, there are two basic approaches for the realization of nonverbal communication of socially interactive robots by way of their face. The first is based on robots with a rigid face with movable eyebrows, eyes, eyelids, and mouth – emotional expression humanoid robot WE-4RII [2], active-vision robotic head MERTZ [3], bipedal humanoid robot KOBIAN [4], human-friendly humanoid robot KIBO [5], emotion-display robot EDDIE [6], expressive anthropomorphic robot Kismet [7], mobile dextrous and social robot Nexi [8], infant-like humanoid robot Infanoid [9], emotional user-interface robot iCat [10], anthropomorphic robot head Flobi [11], huggable robot Probo [12], robotic platform Bandit III [13], emotional expressive robot Melvin [14], social robot Sparky [15], user-interface robot Lino [16], humanoid head robot Amir-II [17] etc. The second approach applies to robots who, instead of faces, have a screen showing characteristic facial parts, such as eyebrows, eyes and mouth – social robot BERT2 [18], mobile platform RASA [19], humanoid service robot R1 [20], social robots iSocioBot [21] and Arash [22], etc. In addition, humanoid platform for cognitive and neuroscience research iCub [23] and Twente humanoid head [24], combine these two approaches by moving their eyes and displaying eyebrows and lips using LEDs.

3. KINEMATIC ANALYSIS

The basic requirement of the realization is to enable rotation and lift of the eyebrows. Figure 2 shows an eyebrows linkage mechanism with 2 DOFs that allows rotation, translation and complex motion of the eyebrows. The mechanism consists of slider 2 – input link for rotation movements and levers 3_L,3_R and 4_L,4_R – working links, while link 5 represents the input/working link for translation movements.

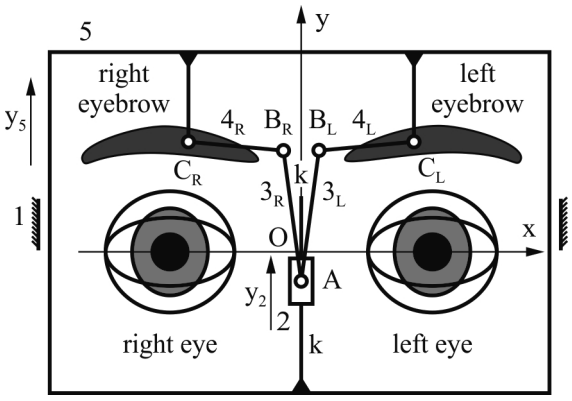

Fig. 2. Eyebrows mechanism with 2 DOFs

Therefore, link 5 performs a translatory motion in relation to immovable link 1 – distance y_5, allowing the eyebrows to be lifted simultaneously. Link 5 is connected to link 2 through links 3_L,3_R and 4_L,4_R. However, link 2 performs a translatory motion in relation to link 5 by the vertical guide k-k. Links 4_L,4_R are connected by rotational joints to link 5 in points C_L,C_R, while they are connected to link 2 by levers 3_L,3_R – points B_L,B_R. The left and right eyebrow are rigidly connected to links 4_L,4_R

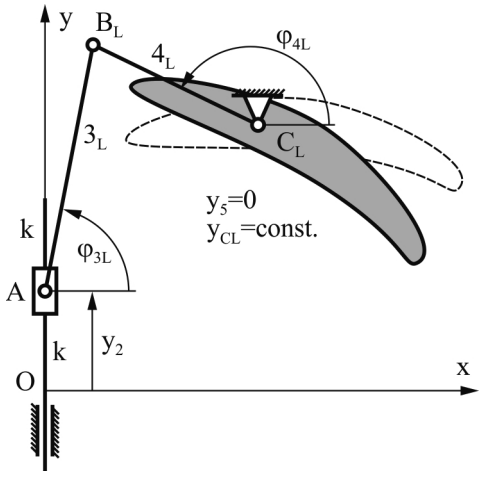

Fig. 3. Mechanism for eyebrows rotation

respectively. By activating the input link 2 – distance y_2, the mechanisms $2,3_L,4_L$ and $2,3_R,4_R$ perform the rotation of the left and right eyebrow simultaneously.

Figure 3 shows the mechanism for eyebrows rotation. Bearing in mind that the mechanism is symmetrical, only one eyebrow is further analyzed, so the indices L – left and R – right can be neglected. During the eyebrows rotation, link 5 does not move, so the mechanism can be viewed as a piston mechanism. Thus, link 2 moves along the fixed guide k-k, while link 4 rotates around the axis passing through the fixed point C. The dependence of the rotation angle of the eyebrow φ_4 from the position of the slider 2 is given by the equation:

$$\varphi_4 = \varphi_d + arccos\frac{r_3^2 - d^2 - r_4^2}{2dr_4} \tag{1}$$

where:

$$\varphi_d = arctan\frac{y_C - y_2}{x_C} \tag{2}$$

$$d = \sqrt{x_C^2 + (y_C - y_2)^2} \tag{3}$$

r_3 – length of the link 3, r_4 – length of the link 4, x_C,y_C – coordinates of point C and y_2 – position of the slider 2. Figure 4 shows the characteristic eyebrow positions – the initial position in which the eyebrows are horizontal (a) and extremely rotated eyebrows positions, upwards (b) and downwards (c). Figure 5 shows a mechanism for lifting both eyebrows simultaneously. Link 5 moves translatory for distance y_5. Eyebrows and mechanisms $2,3_L,4_L$ and $2,3_R,4_R$ move translatory, together with link 5.

The dimensions of the mechanism are as follows: the diameter of the eye is 45 mm, interpupilary distance is 90 mm, length of link 4 is r_4=35 mm and length of link 3 is r_3=45 mm. The position of slider 2 when the eyebrows are horizontal is y_2=–10 mm. When the eyebrows are rotated upwards by an angle of –25°, the slider position 2 is y_2=–24.35 mm, and when the eyebrows rotate downwards to an angle of +25°, the slider position 2 is y_2=5.23 mm. The total stroke of slider 2 is approximately 30 mm, which is 15 mm in both directions.

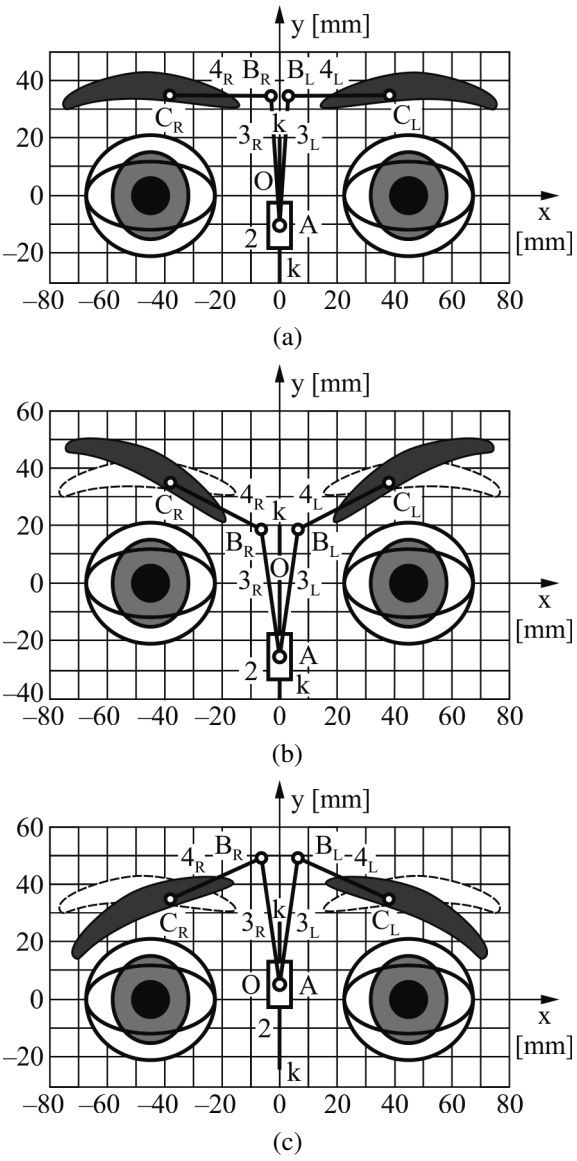

Fig. 4. Characteristic positions of eyebrows: (a) the initial position in which the eyebrows are horizontal, (b) the rotated eyebrows position upwards by the angle –25° and (c) the rotated position of the eyebrows downwards by angle +25°

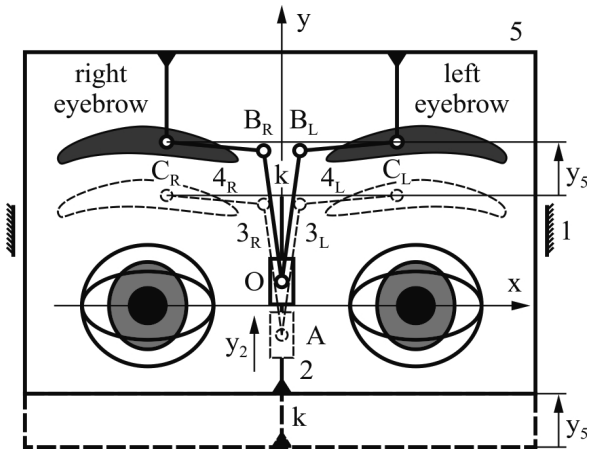

Fig. 5. Mechanism for eyebrows translation

4. CONCLUSIONS

The paper presents an eyebrows mechanism for expressing nonverbal communication of socially interactive robots. Based on the set requirements, an eyebrows linkage mechanism with 2 DOFs is proposed. It consists of two mechanisms. The first one is a 6-bar piston mechanism that allows the rotation of both eyebrows simultaneously, and the second one is a 2-bar linkage mechanism for lifting both eyebrows at the same time. It is also possible to combine these two movements. Within the kinematic analysis, the basic parameters of the mechanisms are defined. The mechanisms are simple structures, have small strokes and dimensions. Further work will include the analysis of different mechanisms for motion transmission from the actuator to the input links – eyebrows, from the aspect of practical realization. In addition, we will consider the biological principles of eyebrows, such as kinematics and anthropometry – the shape, position and dimensions of the eyebrows, as well as the distance between pupils. Based on all of the above, we will implement biologically inspired eyebrows, as an addition to the assortment for expressing nonverbal communication using the face.

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The Effect of Carburizing on the Properties of Steel 20MnCr5 and 18CrNi8

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Abstract

Carburizing is a thermochemical surface hardening process which is used to improve the wear resistance while maintaining toughness and fatigue strength of the core. Carburizing steels are low-carbon steels which surface layer is carburized to the achievement of high-carbon martensitic case with increased abrasion wear resistance. In the experimental part of the paper, the effect of carburizing on the surface hardness and case hardness depth of carburizing steels 20MnCr5 and 18CrNi8 was investigated. The process of carburization was carried out in a gas carburising furnace at the same parameters for both steels. The samples were quenched directly into oil and then tempered. After the treatment, a metallographic analysis was carried out and case hardness depths were determined. The obtained test results have shown that initial composition of carburizing steel effects on case hardness depth and does not effect on the value of surface hardness after carburizing.

Keywords: carburizing, surface hardening; case hardening depth

1. INTRODUCTION

Carburizing steels are structural steels containing 0.1 to 0.2 %C before carburizing. Because of the low-carbon content, before the thermochemical processing, these steels have a low hardness with good toughness.

Depending on the alloy composition, carburizing steels are divided on unalloyed and low-alloyed Cr-; Mn-Cr- and Mo-Cr-; Ni-Cr-; Ni-Cr-Mo- and Cr-Ni-Mo- steels. The selection of appropriate alloying elements permits the required hardenability from the surface to the core. [1]

Carburizing is a thermochemical surface hardening process which is used to increase surface hardness and improve the wear resistance while maintaining toughness and fatigue strength of the core.

Depending on the required use characteristics and the subsequent machining requirements, after carburization and hardening the material is tempered, or deep cooled and tempered. [2]

The level of carbon in the surface layer primarily depends on the carburizing effect of the medium. The process of carburization may take place in solid, liquid or gas source of carbon. In pack carburizing, carbon monoxide is given off by coke or hardwood charcoal. In liquid carburizing, the CO is derived from a molten salt composed mainly of sodium cyanide and barium chloride. In gas carburizing, the source of carbon is a carbon-rich furnace atmosphere produced either from gaseous

hydrocarbons or from vaporized hydro-carbon liquids.

After the diffusion of carbon atoms into the surface layers of a metal, surface carbon content is increased up to 0.8 to 0.9 %.

When the iron or steel is cooled rapidly by quenching, in the surface layer the austenite is transformed to high carbon martensite with hardness of 61 to 64 HRC. [1]

Immediate (direct) quenching of the carburization temperature is usually carried out in liquid carburizing. In solid carburizing, the workpiece is first slowly cooled and after that heated to appropriate temperature and quenched.

After the carburization stage in the gas furnace, the temperature is usually lowered for about one hour before quenching to reduce the risk of distortion. It is reasonable to assume that the material is stress-free when the quenching takes place. [3]

After quenching, case hardened components are tempered at low temperatures (170 °C to 220 °C) in order to retain a high degree of surface hardness.

The core of carburized unalloyed steels is ferritic-pearlitic and the core of carburized alloyed steels is low-carbon martensitic, in case that it is hardened. The structure of the low-carbon martensit ensures high strength of the core with increased fatigue strength and toughness.

Alloying elements, in addition to their impact to hardenability, also affect the rate of carburization, the carbon content in the surface layers and the case hardness depth. Carbide-non-forming elements increase the diffusion of carbon in austenite and reduce the carbon solubility in the surface layer. Carbide-forming elements reduce the carbon diffusion into austenite and thus increase the carbon solubility in the surface layers.

The case hardness depth (CHD) is determined according to HRN EN ISO 4507:2008 and represents the depth, measuring from surface to core, where hardness is 550 HV1.

2. CARBURIZING OF STEELS 20MnCr5 AND 18CrNi8

The effect of carburizing on the surface hardness and case hardness depth was investigated on carburizing low-alloyed steels 20MnCr5 and 18CrNi8.

Cr-Mn-alloyed steel 20MnCr5 is used for components in mechanical engineering and vehicle construction with higher core strength (gear wheels, ring gears, counter shafts…). [4]

Cr-Ni-alloyed steel 18CrNi8 is used for highly stressed components in mechanical engineering and vehicle construction. [4]

The chemical compositions of investigated steels are shown in Table 1.

Table 1. Chemical compositions of steels 20MnCr5 and 18CrNi8 [5]

Steel	C, %	Si, %	Mn, %	Cr, %	Ni, %
20MnCr5	0.17-0.22	≤ 0.4	1.1-1.4	1.0-1.3	-
18CrNi8	0.15-0.2	0.15-0.4	0.4-0.6	1.8-2.1	1.8-2.1

The 20MnCr5 steel sample has a round cross section of 10 mm in diameter and the 18CrNi8 steel sample has a rectangular cross section of 12 × 18 mm. After the carburizing process, surface hardness measurements using the HRC method, metallographic testing and determination of case hardness depth by Vickers method were carried out.

2.1. Parameters of the carburizing process

The temperatures of the particular stages of the carburizing process and the quenching media are shown in Table 2.

The process of carburization was carried out in a gas carburising furnace at the same parameters for both steels to determine the difference between the case hardness depth and the achieved surface hardness.

Table 2. Temperatures of the particular stages of the carburizing process and the quenching media of steels 20MnCr5 and 18CrNi8 [5]

Parameters of the carburizing process	Steel	
	20MnCr5	18CrNi8
Carburization, °C	880 - 980	900 - 950
Surface hardening, °C	780 - 820	800 - 830
Core hardening, °C	860 - 900	840 - 870
Quenching media	Water, oil, hot quenching	
Tempering, °C	170 - 200	170 - 210

The selection of the carburization temperature (Table 3) was performed with the aim of increasing the depth of carbon diffusion.

Table 3. Relationship between the temperature and the case hardness depth [6]

Carburization temperature	Case hardness depth
900 °C	≤ 0.5 mm
930 °C	0.5 – 1.2 mm
950 – 980 °C	≥ 1.2 mm

For a case hardness depth of CHD ≈ 1.2 mm the selected temperature is 930 °C.

The time of carburization is determined by the temperature and the case hardness depth as shown in Table 4.

Table 4. Determination of carburization time based on the carburization temperature and case hardness depth [6]

Carbur. temperature	Carburization time, h						
	0.5	0.8	1.0	1.2	1.5	2.0	2.5
900 °C	1.2	3.3					
930 °C	0.7	1.8	2.8	4.0	6.2		
950 °C			2.1	3.0	4.6	8.0	12.5
980 °C						4.5	7

For carburization temperature of 930 °C and case hardness depth of ≈ 1.2 mm, carburization time of 4 h (240 min) was chosen.

Diffusion time is determined by carburization temperature and case hardness depth as shown in Table 5.

The diffusion time for a temperature of 930 °C and case hardness depth of 1.2 mm should be 0.7 h (40 min). Since no direct oil quenching is performed, but the workpieces are cooled in the furnace to a temperature of 820 °C, during which time the diffusion process is carried out, the diffusion time is determined for 20 min.

Table 5. Determination of diffusion time based on carburization temperature and case hardness depth [6]

Carbur. temperature	Diffusion time, h						
	0.5	0.8	1.0	1.2	1.5	2.0	2.5
900 °C	0.2	0.3					
930 °C	0.1	0.3	0.5	0.7	1.2		
950 °C			0.3	0.5	0.8	1.5	2.5
980 °C						1.2	2.0

Determination of the minimum and maximum C-potentials for a particular temperature for the Supercarb process is shown in Table 6.

Table 6. Determination of C-potential based on carburization temperature [6]

Carburization temperature	C-potential
900 °C	0.95 – 1.10 %C
930 °C	1.05 – 1.20 %C
950 °C	1.10 – 1.25 %C
980 °C	1.20 – 1.35 %C

For carburizing temperature of 930 °C according to table 6, the recommended C-potential is between 1.05 and 1.20 %C. In the experiment, the C-potential of 1.04 %C was chosen due to the reduced possibility to create harmful soot in the furnace chamber. C-potential of diffusion is determined by the material as shown in Table 7.

Table 7. Determination of C-potential depending on carburized material [6]

Material	C-potential
Unalloyed steels	0.8 – 0.9 %C
Cr- and Mn-alloyed steels	0.75 – 0.8 %C
Ni-alloyed steels	0.65 – 0.7 %C

The choosen C-potential of diffusion is 0.7 %C based on the types of steels which are carburized.

The process of carburization was carried out in a gas carburising furnace at the same

parameters for both steels. The samples were cooled to 820 °C, quenched directly into oil and then tempered.

According to table 2, selected austenitization temperature of the surface is 820 °C and selected tempering temperature is 180 °C.

2.2. Carburizing process

Preheating of samples made of steels 20MnCr5 and 18CrNi8 was carried out in furnace IPSEN DA-8 at a temperature 480 °C for 120 min.

Pre-heated samples were transferred to the furnace for carburizing IPSEN TQF-7-(8). As the carburizing gas, natural gas was used with the addition of air for regulation of C-potential. The atmosphere is controlled by an O_2-probe and a CO-analyser. The diagram of carburizing is shown in Figure 1.

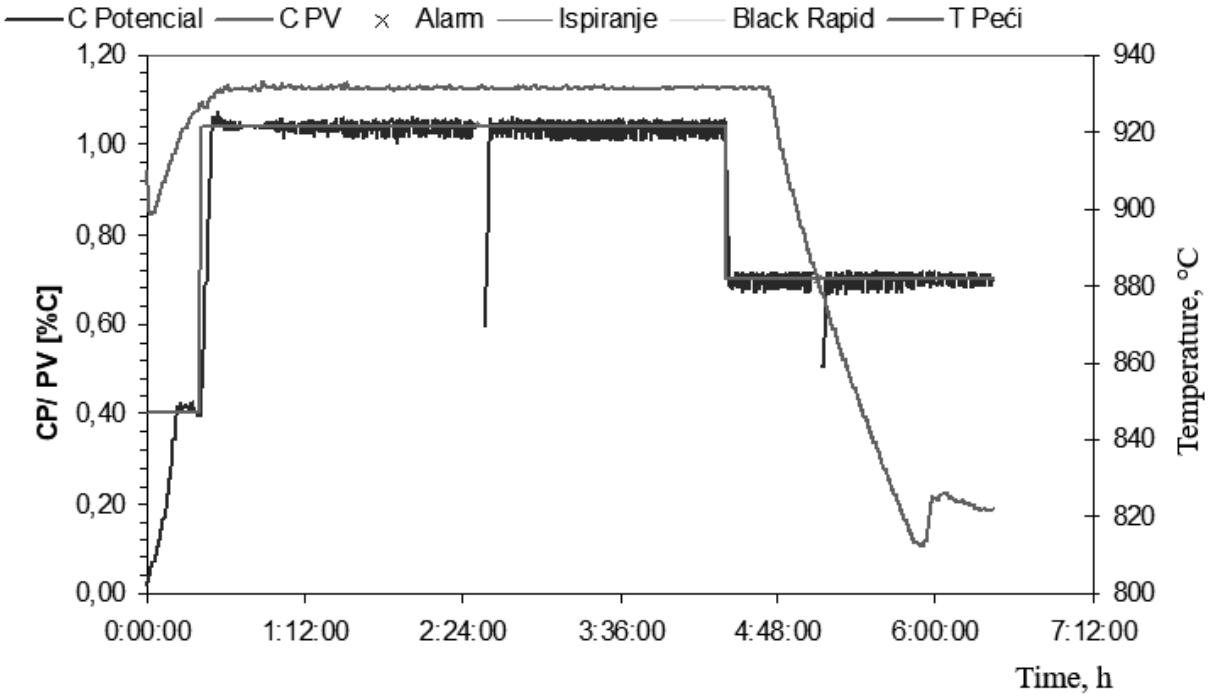

Fig. 1. Gas carburizing in the furnace IPSEN TQF-7-(8)

After carburization for 30 min and cooling up to 820 °C, direct quenching in oil was carried out with intense mixing.

After hardening and washing of samples, low-temperature tempering was carried out at a temperature of 180 °C for 120 min.

2.3. Measurement of surface hardness

Both carburized samples were measured after hardening (Table 8) and after low-temperature tempering (Table 9) by surface hardness HRC.

Table 8. Surface hardness after hardening

Steel	$HRC_{measured}$			HRC_{mean}
20MnCr5	65	65	64	65
18CrNi8	66	66	65	66

Table 9. Surface hardness after low-temperature tempering

Steel	$HRC_{measured}$			HRC_{mean}
20MnCr5	59	59	60	59
18CrNi8	58	59	58	58

2.4. Metallographic testing

For the metallographic testing, the carburized 20MnCr5 and 18CrNi8 steel samples were cross over cut in half, plunged into plastic mass, faceted, polished and corroded (Nital 3 etching).

At magnification 240:1, metalographic images of the carburized surface layer, the transition zone and the core of carburized steels 20MnCr5 (Figure 2) and 18CrNi8 (Figure 3) were made.

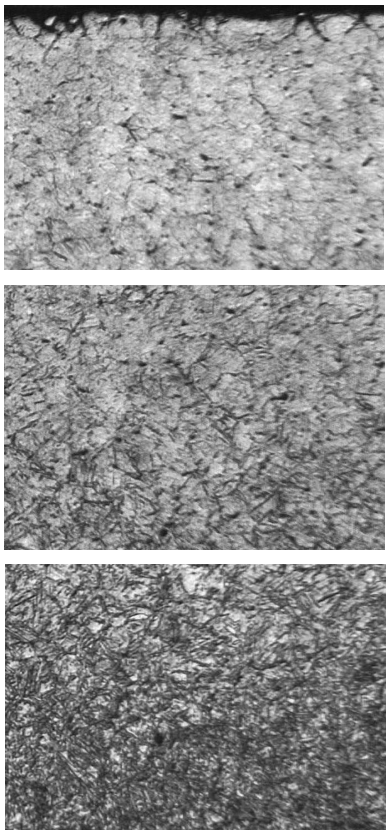

Fig. 2. Metallographic image of carburized steel 20MnCr5 (Magnification 240:1, Nital 3 etching)

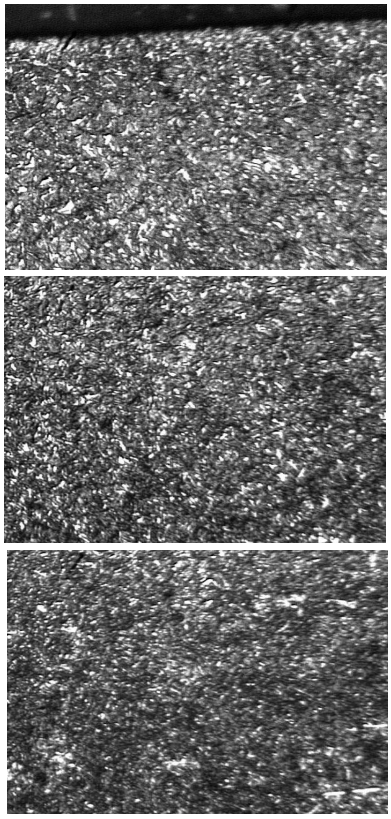

Fig. 3 Metallographic image of carburized steel 18CrNi8 (Magnification 240:1, Nital 3 etching),

2.5. Determination of case hardness depth

Determination of case hardness depth is prescribed by Standard HRN EN ISO 4507:2008.

Hardness measurement by HV1 method is performed on transversally cut carburized samples perpendicular to the edge to the point where the hardness of 550 HV1 is reached.

Both of the samples were conducted measurements of hardness on two opposite lines ($HV1_I$ and $HV1_{II}$) from the outside towards the core to a depth of 1.5 mm and with a spacing of 0.1 mm.

The results of the cross-section HV1 hardness measurement of 20MnCr5 and 18CrNi8 carburized samples are shown in Table 10.

Table 10. Hardness of cross section of carburized steels 20MnCr5 and 18CrNi8

Distance from the edge, mm	20MnCr5		18CrNi8	
	$HV1_I$	$HV1_{II}$	$HV1_I$	$HV1_{II}$
0.1	766	742	805	792
0.2	766	772	805	785
0.3	722	798	772	792
0.4	779	805	760	772
0.5	792	798	742	742
0.6	772	798	713	660
0.7	825	785	686	660
0.8	779	785	636	636
0.9	760	766	613	581
1.0	742	760	551	571
1.1	713	699	515	524
1.2	636	624	498	515
1.3	581	581	467	482
1.4	533	541	452	468
1.5	487	498	446	452

The diagram of determination the case hardness depth of the carburized sample of 20MnCr5 steel is shown in Figure 4.

The diagram of determination the case hardness depth of the carburized sample of 18CrNi8 steel is shown in Figure 5.

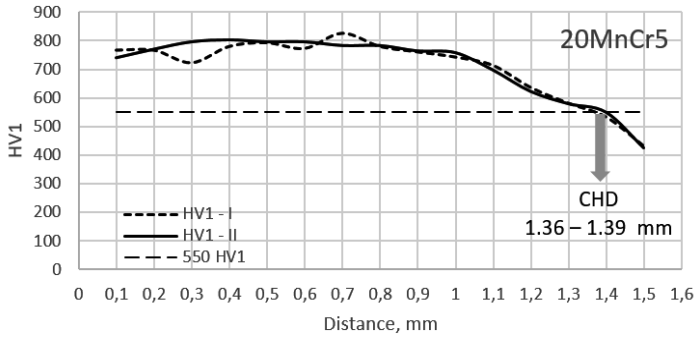

Fig. 4. Determination of the case hardness depth of the carburized steel 20MnCr5

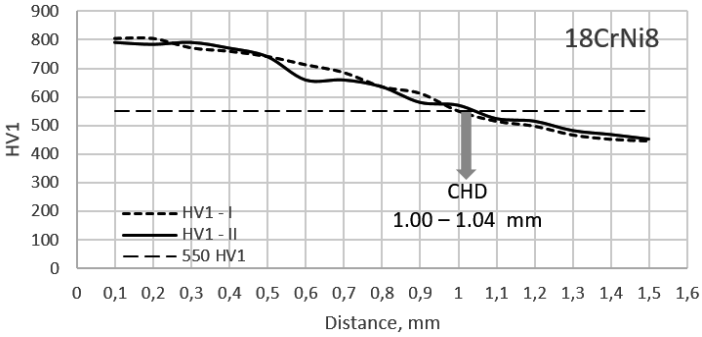

Fig. 5. Determination of the case hardness depth of the carburized steel 18CrNi8

3. CONCLUSIONS

After the carburizing process carried out at the same parameters on two low-alloyed carburizing steels 20MnCr5 and 18CrNi8, the analysis of the measured results of the surface hardness, metallographic tests and the determination of case hardness depth, it may be concluded that:

- Approximately the same surface hardness of both carburized steels is achieved.
- The case hardness depth is greater for 20MnCr5 steel than for 18CrNi8 steel, indicating the adverse effect of higher chromium content and nickel addition on carbon diffusion.

When defining the parameters of carburization process, it is necessary to take into account the mass portion and the type of alloying elements. For more alloyed steels, especially with chromium and nickel, it is necessary to heighten the diffusion of carbon by increasing the carburization temperature or extending the carburization time.

The obtained test results have shown that initial composition of carburized steel effects on case hardness depth and does not effect on the value of surface hardness after carburizing.

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Comparative Stress Analysis of an Artillery Projectile Body

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Abstract

This paper presents comparative stress analysis of an artillery projectile body using FEM and classical theoretical method. The aim of this analysis is to show that results of stresses in characteristic cross sections obtained by the classical theoretical method and stresses obtained by FEM calculation gives good agreement. The projectile 105 HE M1 was used as an example for the comparative stress analysis. Based on the results and their good match, it can be concluded that the numerical FEM analysis can be reliably used for strength analysis of various types of artillery projectile bodies.

Keywords: artillery projectile body, 105 mm calibre, stress analysis, FEM, axisymmetric finite element

1. INTRODUCTION

Artillery projectiles are subjected to extremely high loads during firing. Because of that the design of artillery projectiles presents a very serious task. During the design process it is necessary to predict lot of issues: safety during exploitation (primarily during projectile travel through the barrel), proper effects on the target, achieving a maximum possible range for the given launching conditions, low cost production, maximum productivity and etc. All of these requirements are often contradictory and it is necessary to find some kind of appropriate compromise for optimum design. However, safety conditions are at the first place.

During the movement process through the barrel, the projectile is exposed to the effect of force and momentum caused by action of the gunpowder gas pressure. The parts of the projectile, especially artillery projectile body and the driving band, must be dimensioned so that the stresses that occur during the process of firing do not cause large deformations which would trigger a projectile explosion in the barrel or on the trajectory. In order to satisfy safety conditions it is necessary to determine the state of stress in the projectile body during the process of firing.

There are many diferent methods strength assesment of artillery projectile body during the process of firing. Some analytical calculation methods are developed, unabled and presented in [1-3]. In addition to analytical calculations, some authors also developed some numerical methods for stress analysis of artillery projectile body during the process of firing [4-5].

The aim of this paper is to present comparative stress analysis of an artillery projectile body using FEM and analytical calculation method. As an example projectile 105 HE M1 was used.

2. CLASSICAL THEORETICAL METHOD

Until the appearance of modern computers, the methods for stress analysis of the projectile body were very limited. The load and boundary conditions which appear during firing process of projectile exclude the possibility of direct

experimental measurement of stresses and strains. Because of these facts classical theoretical methods based on analytical calculation were the only way to determine stress state of artillery projectile body. The projectile 105 HE M1 (Figure 1.) was used as an example for analytical calculation and further for comparative analysis of obtained results. All the data necessary for analytical calculation the axial stresses in the artillery projectile body are given in Table 1.

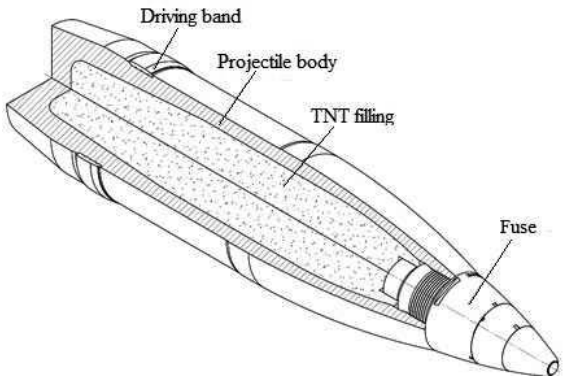

Fig. 1. 105 HE M1 artillery projectile

Table 1. Basic data for calculation

Mass of the *105 HE M1 artillery projectile*	$m = 14.95\,kg$
Maximal pressure of the gunpowder gas pressure	$p_m = 230\,MPa$
Data for barrel of Howitzer 105 mm M56 (Figure 2.)	
Number of grooves	$n = 36$
Inner diameter	$d = 105\,mm$
Outer diameter	$d_0 = 106.7\,mm$
Groove's width	$e = 5.3\,mm$
Angle of groove's twisting	$\tan\varphi = \tan 8^o$
Cross section area of the barrel	$s_c = \frac{d^2\pi}{4} + \frac{ne}{2}(d_0 - d) \quad [MPa]$
Forces and pressures	
Calculated pressure	$p_{pr} = k_1 k_2 k_3 p_m \quad [MPa]$
Corection factors	$k_1 = 1.15 - 1.18;\ k_2 = \frac{1}{1 + \frac{1}{2}\frac{\omega}{\varphi_1 m}};\ k_3 = 1.15$
Total from gunpowder gas pressure	$F_b = p_{pr} s_c \quad [N]$
Normal force on active surface of driving band's tooth	$N = \frac{I_x}{n}\frac{4}{d^2}\frac{\tan\varphi}{\cos\varphi}\frac{p_{pr}}{m}s_c \quad [N]$
Axial moment inertia of projectile	$I_{xx} \quad [mm^4]$
Axial force on one tooth of driving band	$F_{na} = N(\sin\varphi + f\cos\varphi) \quad [N]$
Friction coeficient (steel – cooper)	$f = 0.2$
Total axial force of driving band	$nF_{na} \quad [N]$
Acceleration	$\frac{d^2z}{dt^2} = \frac{1}{m}(p_{pr}s_c - nF_{na}) \quad \left[\frac{mm}{s^2}\right]$

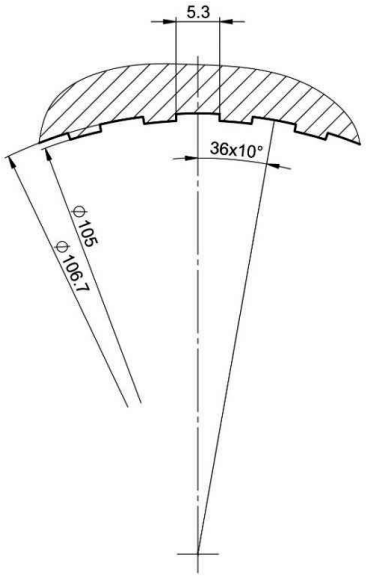

Fig. 2. Cross section of Howitzer 105 mm M56 barrel

In order to calculate the stress state, it is necessary to split the projectile body into cross-sections, which are placed in characteristic places where suddenly changes in the geometry of projectile body occur, Figure 3. For each cross section *i-i*, the inner and outer diameters of the projectile body are determined, as well as the mass of the part of the projectile in front of the cross section.

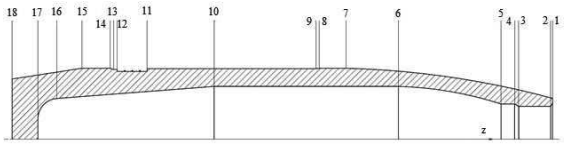

Fig. 3. Cross-section of projectile body for calculating stress state

The stresses in the projectile body were calculated with different equations in dependence on position of the cross section. The stresses in the zone in front of driving band (cross sections 1-11) were calculated using equation

$$\left(\sigma_p\right)_{i-i} = \frac{m_A}{S_{i-i}} \frac{d^2 z}{dt^2}. \quad (1)$$

The stresses in the zone behind of driving band, in front of rear cone (cross sections 12-15) were calculated using equation

$$\left(\sigma_p\right)_{i-i} = \frac{1}{S_{i-i}} \left(m_A \frac{d^2 z}{dt^2} + nF_{na} \right). \quad (2)$$

The stresses in the zone of rear cone (cross sections 16-18) were calculated using equation

$$\left(\sigma_p\right)_{i-i} = \frac{1}{S_{i-i}} \left(m_A \frac{d^2 z}{dt^2} + nF_{na} - p_{pr}\left(s_c - r_o^2 \pi\right) \right). \quad (3)$$

In equations (1) - (3) m_A represents mass of projectile's part left from cross section *i-i* (including mass of fuse and TNT filling). S_{i-i} represents area of projectile body in cross section *i-i* which can be calculating using equation (4)

$$S_{i-i} = \pi\left(r_o^2 - r_i^2\right), \quad (4)$$

whereas r_o and r_i are outer and inner radius of projectile body in cross section *i-i*.

Stress distribution of 105 HE M1 artillery projectile body in characteristic cross sections calculated using classical theoretical method are shown in Figure 4. Maximum value of the stress in projectile body is 467.25 MPa and occurs at the place of groove for driving band.

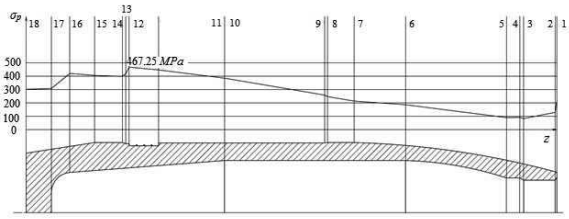

Fig. 4. Stress distribution of 105 HE M1 artillery projectile body – analytical calculation

3. FEM AND COMPARATIVE ANALYSIS

In accordance to CAD model, the artillery projectile body is modelled using the Femap software with NX Nastran solver [6], which operates based on the finite element method. The model of projectile body in all cross sections along longitudinal axis of symmetry retains the same material and geometric properties so for creating FEA model axisymmetric finite elements were used. The structure is modelled in details with 8077 elements and 8534 nodes. General element side length is about 1 mm.

As it was case in analytical calculation, the fuse is not modelled. The fuse influence is replaced with equivalent pressure acting on front area of the projectile body. The value of this pressure is product od fuse mass, acceleration and area of fuse reliance on the projectile body. Load and boundary conditions of projectile body for numerical calculation are shown in Figure 5.

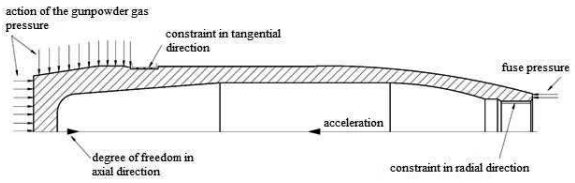

Fig. 5. Load and boundary conditions of projectile body

Stress distribution of 105 HE M1 artillery projectile body using FEM are shown in Figure 6. Maximum value of the stress in projectile body is 470.81 MPa and occurs at the place of groove for driving band.

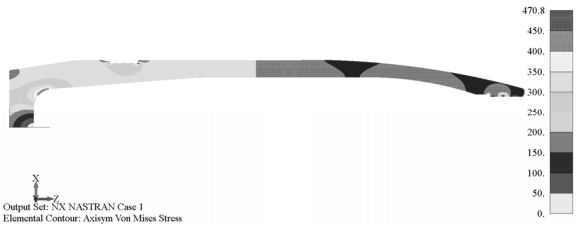

Fig. 6. Stress distribution of 105 HE M1 artillery projectile body – FEM calculation

In order to show comparative stress analysis, curves of stress distribution obtained using analytical and numerical methods are shown in Figure 7. Comparing the numerical results with values of stresses in characteristic cross sections calculated by analytical method, it is shown that difference is approximately less than 10%.

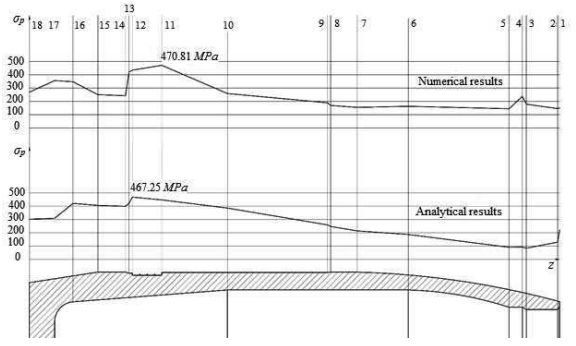

Fig. 7. Stress distribution of 105 HE M1 artillery projectile body – Comparative analysis

4. CONCLUSIONS

The aim of this paper was to present some methods for determining the stress state of projectile body during the firing process. The comparative stress analysis of an artillery projectile body using FEM and classical theoretical method was done. Comparing the numerical results with values of stresses in characteristic cross sections calculated by analytical method, it is shown that FEM gives a little higher value of stresses. Based on the fact, that it is not possible to perform a stress state analysis experimentally, it can be concluded that the numerical FEM analysis can be reliably used for strength analysis of various types of artillery projectile bodies.

5. ACKNOWLEDGEMENTS

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Possibilities of NC Program Creation within Information System Designed under Industry 4.0 Requirements

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Abstract

The article deals with possibilities of NC program creation within the information system designed in accordance with Industry 4.0 requirements. A specific situation in Slovak production is described in introduction, where the problems of industrial companies have been shortly analysed. A necessity of complex information system was identified as one of the requirements for manufacturing efficiency increasing. Based on the findings, new information system with respect to specific features of Industry 4.0. was designed at FMT TUKE. One part of the software application is devoted to NC program creation. Possibilities to use the system in this way and an example of NC program generation for a shaft created within group technology are presented in the article.

Keywords: information system, NC program, representative, Industry 4.0

1. INTRODUCTION

The 20th century provided an extended period of peace and prosperity as well as co-operation and stability in much of the world. The challenges confronting global decision makers are now more complex, intertwined, and growing in intensity and urgency. Traditional methods of co-ordinating responses and negotiating action to combat shared threats are challenged by the speed and power of new technologies, which allow individuals and organisations to stay one step ahead of formal regulations. Current situation in industry is characterized as a period of intense progress of technologies at the significant computer aid in all branches of industry. In connection with the technical progress, the pressure on the manufacturers to develop and make the products as soon as possible at a minimal cost in required quality is still increasing. On the other hand, the product has to be competitive, it has to be up to qualitative and functional standard, it has to have reasonable price, efficacious design, and it has to consider safety, ergonomic and other aspects, which will decide about its marketability. [1,2]

The substantial influence on the technical, social and economic level of manufacturing process improvement has the computer technique implementation into technological preparation of manufacturing. A company that uses computer aid in this production phase is able respond very quickly on the change produced assortment. It is allowed also by high computing power including hardware and software. One of the most important issue of company efficiency increasing is right selection of CAPP (Computer Aid of Process Plan) system that would be flexible and would be able to modify already existed technological

documentation or to create completely new documentation. Knowledge-level system can help the company to discover, organize and integrate new knowledge into business and to control the flow of paperwork. [3]

2. CHARACTERISTICS OF SLOVAK PRODUCTION

Many of Slovak plants were obliged to transform their production schedule, quantity, types and kinds of products, after 1989 (the year of marked political-sociable changes in previous Czechoslovak republic), but they work with unchanged philosophy up to this day. This is one of the reasons why they are still out of a competition with west companies, despite cheaper manpower. Currently, Slovak production can be characterized in following ways: [4]

- Slovakia is specialised in low value-added manufacturing goods - the share of domestic value-added in exports is low, because of mainly assembly or components manufacturing.
- Score of Slovakia on the Services Trade Restrictiveness Index (STRI) is better than the OECD average in 14 out of 17 service sectors, pointing to the relative liberal regulatory regime applicable to foreign entry in services.
- Position of Slovakia in global value chains (GVCs) is relatively weak because of the low input of R&D - 0.3% - in OECD 1.6%. [5]

Innovation capacity of Slovakia is still weak and, as can be seen from Figure 1, the capacity of Central and Eastern Slovak companies to absorb technology is also weak.

Other problems of Slovak companies are: [6,7]

- low level of information technology (live data, uniformity of information structures).
- computer aid doesn´t have systemic character (only subprograms are used within difficult systems, which are often incompatible);
- absence of tools, which would be able to analyse dynamic system properties at short time.
- missing of the tools and time space for other alternative solutions, including possibilities of their testing and optimization.

These facts force on manufacturers to debug the limitations listed above. A management team in a company needs to be more innovative to have new business strategies as competitive advantage. One of the solutions is to build information systems, which integrate needed data and provide live data to each workman, that are necessary for labour-saving work and for the receiving sufficient decisions. All information represents the know-how of the plant, so it is important to store this information. It is suitable to archive all data in digital form today and use it in various stages of the manufacturing process. It is very important for the operator to know the data flow and on the basis of this knowledge made it as simple as possible. It enables: [8-10]

- to increase of production effectivity and quality,
- to adapt data structure dynamically to actual situation and for user specific conditions with minimum negative effects,
- to select the way of process plan creation, whether it will be used within group technology or whether it will be done for every part separately. If the part is made by means of NC machine, the producer should be able to decide in which way the NC program will originate, whether it will be written manually or whether it will be created using CAM system;
- to select the parts with the similar material and dimensional characteristics, with the similar process plans; therefore, it will be considerably able to save the batch time,

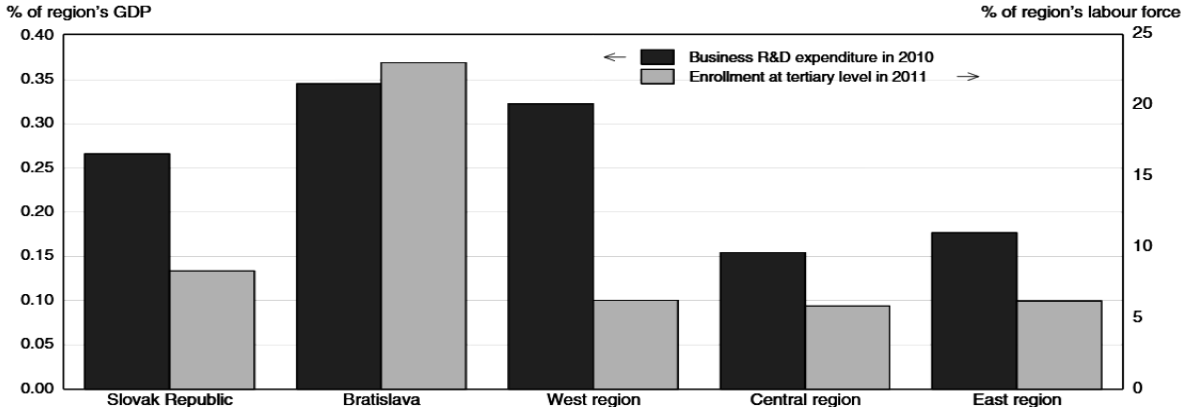

Fig. 1 Capacity of Central and Eastern Slovak companies to absorb a technology

- to import processed parameters easier and faster,
- to short preparing time for the technological documentation,
- to use information not only for the generating of technological documentation, but also to the processing of details for store, economic and wage records.

A requirement to dispose a software application, that would satisfy all criteria for information system and would be adaptable to Slovak market conditions, brings to manufacturers idea to create new system in collaboration with academic researchers. That was a reason why the Faculty of Manufacturing Technologies of Technical University in Kosice was connected to the practically oriented project focused on the development of new information system. Software application has been called IAS, what means Individual Application System. The input environment of IAS is shown in Figure 2.

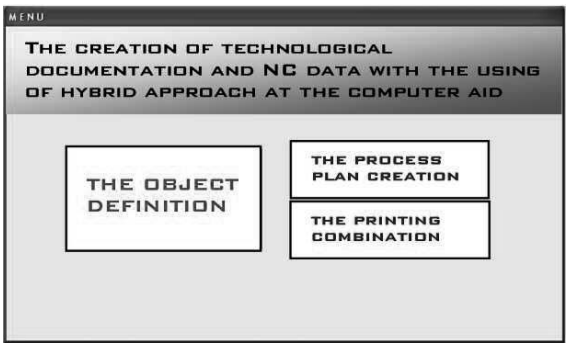

Fig. 2. Basic application Menu

3. POSSIBILITIES OF NC PROGRAM CREATION WITHIN "IAS"

Introducing of PC into process plans creation considers that every process plan consists of two parts: [11,12]

- operating part, which determinates the operation type (e.g. tooling, milling, grinding, ...)
- information flow, which represents processing of all information needed for the manufacturing operation controlling.

Both these parts listed above has found their application at controlling NC machines in flexible conditions of automated production through NC programs.

To be newly designed IAS software application more than flexible from the point of view of NC machine operator, it was created so to be operator able to prepare NC program using following approaches:

- "Hand programming" by direct writing of NC program. It is suitable for very simple operations. Typical example is a turning.
- Partially automated program preparation by direct selection of commands from the IAS environment. It is usually used within group technology for simple parts, mainly at the turning, with possibility to apply other types of machining, e.g. milling).
- Automatically generated NC program under CAD/CAM system conditions. NC

program is saved in native format of control system of selected production machine through IAS software application (NC program is related to the part - all commands for NC processing are in one file or it is related to the group of operations that results to specific shaped feature, for example no cylindrical hole). This approach of NC program generation is suitable for complex shaped parts, where NC program can consist of several thousand rows. The generation is done on the basis of geometric data about part, tool, jigs, etc. It depends on the choices technology and execution strategy.

An example of possibility to create NC programs generated in partially automated way with utilization of group technology inside IAS can be shown on group representative for shaft parts shown in Figure 3. It contains most frequent types of outside, respectively inside, surfaces and features of shafts, such as cylindrical surfaces, conical surfaces, threaded surfaces, concave surfaces, convex surfaces, chamfers, rounds.

Fig. 3. Complex - group representative

It is necessary to realise that utilization of group representative for NC program creation depends on many factors and NC program already once generated may not be suitable for another type of control system, respectively another type of the machine. What makes CNC so flexible and productive is the ability to run different workpiece programs. With the right program, machining is a pushbutton affair. [13]

Also, a regime of the material cutting may not be identical (e.g. the control system doesn't allow to made the same continual out surface contour by the cycle, in this case it is necessary to cut every individual surface separately). [14]

From the view of flexible accommodation to concrete situation it would be suitable to prepare NC programs of various representatives for various control systems and these programs very quickly modify in case of requirement or use another type of process plan from IAS menu. Also, it is necessary to say that functionality every made NC programs is important to verify in a practice and consequently the program to debug. It is the same in the case of NC programs prepared in the IAS conditions. Production preparation based on the database principles allows a greater flexibility a manufacturing unit.

On the basis of representative shown in Figure1, PTC Creo as one of big CAD/CAM systems was used for 3D model creation. It also allows to create other similar parts within group technology. It is realized in Family Table module by the feature skip variation through commands Yes/No or by dimensions changes. The environment for new part definition on the basis of already existed is on the Figure 4.

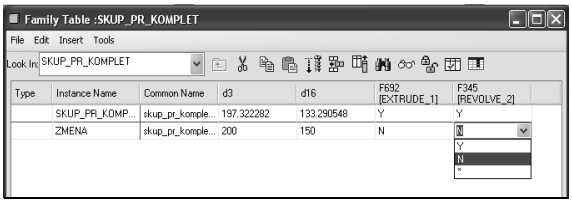

Fig. 4. Preparation of new component within group technology

Some parts generated by means of Family table following one group representative are shown in Figure 5.

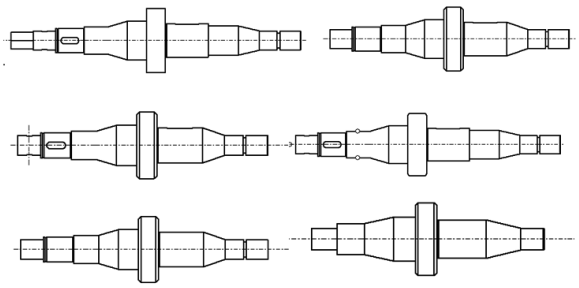

Fig. 5. The parts generated based on group representative

The parts in the figure above have originated by varying some features (surfaces with the certain shape, lock grooves, slots, chamfers, rounds, etc.) which are included into these parts.

Verification of IAS was carried out based on two possible approaches to the technological documentation preparation. It was done

- for a group representative or a component classified into the set of the representative,
- for a component not classified in the set of the representative.

The process plans and NC programs in the module *Process plan creation* were done for every type. Consequently, these outputs were generated through the *Print sets*:

- Process plan,
- NC program for derived part,
- Production time summary.

Data and technological process verification was realized for the part displayed in Figure 6. It was prepared on the basis of group representative (shown in the Figure 3) by means of Family Table module in CAD/CAM system.

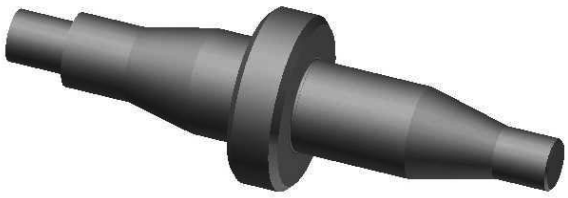

Fig. 6. 3D model of parts for NC program verification

The model listed above was inside database assigned to group representative. Its characteristics were uploaded to IAS interface and it is shown in Figure 7. .

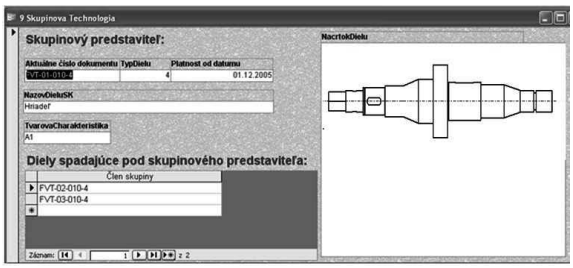

Fig. 7. The object/component assignment to the group representative

CL data generated in CAM system were transformed by means of postprocessor to NC program for the selected control system. After that NC program was fine-tuned and the final version of the machining process was launched.

No problem occurred during machining and shaft successfully produced

4. CONCLUSIONS

On the basis of the aforementioned theory characteristics, the information system was created and applied into real production conditions in the computer aided process planning consisting of approximately 6,000 components. The given product was a result of the co-operation between a German company, providing investments and co-operation of the activities, and Slovak companies providing a technical process planning and the production of a final product.

The main contributions of assigning IS, elaborated on the basis of the multi-variable process planning in the real manufacturing conditions, can be summarized as follows:

- reduction of the variability of warehouse stock (at the first application by nearly 30 per cent),
- immediate information about the product elaboration,
- fast acquisition of the details via interfaces for the wage records and accounting,
- elastic analytical tools enabling the adoption of better decisions,
- acquisition of the statistical values of parameters applicable to plan production in the future.

The software tool was created in the way to be easily implemented to an already existing information company structure via flexibly adjustable interfaces. It is also user-friendly, developed with the characteristics of GUI, typical for OS MS Windows, so that the basic grasp of its functioning does not require expensive trainings. Of course, if the maintenance of this system is to be productive, it must be familiarized with the given philosophy

and possibilities of tactic and strategy planning, through which the production can be optimized. The priorities of authors in a near future is to study:

- general format of process plan data,
- production environs in other European countries,
- graphical features used for process planning.

5. ACKNOWLEDGEMENTS

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Spline Interpolation of SRIM Data for Quantitative Rutherford Back Scattering Analysis

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Abstract

Rutherford Back Scattering (RBS) is a well-established experimental technique widely used in non-destructive depth profiling of elements in surface layers of material [1]. Generally the exact determination of depth profiles of elements using standard RBS data is still a non-trivial task because of relatively complicated changes of ion energy losses that occur during transport of the probing ion inside the material structure. Average energy losses of ion can be determined from Bethe-Bloch analytical theory [3-8] (in high velocity region) and Lindhard-Scharff-Schiøtt (LSS) theory [9-12] (in low velocity region). Currently there is no acceptable theory to determine energy losses of ion in intermediate-velocity region [13] and experimental database must be used in this case. In our work we present stopping power calculations in intermediate-velocity region of ion (i.e. in the region uncovered by exact theory) based on quadratic spline interpolation of experimental data while Bragg`s rule of additivity from individual constituent atoms is assumed for the target from mixtures and compounds. Calculation has been carried out with experimental data that has been taken from Ziegler, Biersack [14] and which are included in SRIM software library. Energy distribution of ion along its trajectory inside the material was found.

Keywords: stopping power, Bethe-Bloch theory, Bragg`s rule, Rutherford Back Scattering, depth profiling, spline interpolation.

1. INTRODUCTION

RBS is a technique suitable especially for standard deep profiling in the case where data of energy losses of ion in material structures are available [2]. The problem of stopping power is dominant in depth profiling from Rutherford Back Scattering (RBS) data. The stopping power is mean decelerating force applied to the ion traveling in the material. Two basic energy transfer mechanisms are dominant in this case. One arises from collisions of ion with target atoms (nuclear stopping power S_n) and other from processes of excitation and ionisation of target electrons (electronic stopping power S_e). The total stopping power is determined by the sum of mentioned components [14]:

$$S_{total} = S_n + S_e = \left(\frac{dE}{dx}\right)_n + \left(\frac{dE}{dx}\right)_e$$

The electronic stopping power reachs its maximum referred to as the Bragg peak at

energies which are higher in order of magnitude then the nuclear stopping.

Slowing down force (stopping power) of ions in matter is a subject which still receives a great theoretical and experimental interest. It was found that ions moving fast lose kinetic energy mainly via electronic stopping [15]. If the ion moves slowly, it carries all of its electrons with it. If the ion is moving faster then fastest electrons in target, it loses all its electrons and is completely ionized. An ion moving slowly loses energy only to the free electrons of the target due to momentum exchange with them. This leads to the linear dependence of the stopping power velocity [16]. A high velocity ion can be considered to be a point-like charge, which can collide with all electrons in the target. The electronic stopping power is then inversely proportional to the square of the ion velocity [17]. When the ion velocity is between two cases, the ion is partially stripped leading to a considerably more complicated description [18], because the ion may lose electrons to, and capture them from, the target. So the values of velocity of the ion can be classified under one of the following three regions:

1) Low-velocity region, where the ion velocity v is below the Bohr velocity v_0 of the target electrons, i.e. the velocity of fastest electrons in the material (in the electron gas theory the limit is commonly the Fermi velocity). The ion moving by this velocity is called slow and average electronic stopping power of such ion results from Lindhard-Scharff-Schiøtt (LSS) theory [9-12]:

$$\left\langle \frac{dE}{dx} \right\rangle_e = -\frac{32\pi^2 \varepsilon_0 \hbar^3}{m_e e^2} \frac{\rho}{m_{at}} z^{\frac{7}{6}} Z \left(z^{\frac{2}{3}} + Z^{\frac{2}{3}} \right)^2 v \quad .(1.1)$$

The universal reduced nuclear stopping power of ion in this low-velocity region was determined by G. Moliere in the framework of Thomas-Fermi potential [26]. The following empirical formula can used to approximate nuclear stopping power calculation near maximum of $S_n(E)$:

$$\left\langle \frac{dE}{dx} \right\rangle_n = -\frac{\rho \pi e^2 a}{8\varepsilon_0 m_{at}} \left(\frac{zZM_{ion}}{m_{at} + M_{ion}} \right), \qquad (1.2)$$

where ρ is the density of the material, e is electron charge, ε_0 is electric permittivity of vacuum, z is charge state of ion, Z is atomic number of target atoms, M_{ion} is mass of ion m_{at} is mass of target atoms, $\hbar$ is reduced Planck constant and parameter a = 1,4.10^{-2} nm. The nuclear stopping power is of the same order of magnitude as electronic stopping power for very slow ions and must be taken into account.

2) High-velocity region, where the ion velocity $v > v_m$. v_m is the mean velocity of electrons filling the levels of a neutral atom with nuclear charge z obtained from the Thomas-Fermi statistical theory [19]:

$$v_m = v_0 \sqrt[3]{z^2} \quad .$$

The ion moving by this velocity is called swift and average electronic stopping power of such ion results from Bethe-Bloch theory [3-8]:

$$\left\langle \frac{dE}{dx} \right\rangle_e = -\frac{4\pi z^2}{m_e v^2} \frac{N_A Z \rho}{A M_u} \left(\frac{e^2}{4\pi\varepsilon_0} \right)^2 \left[\ln\left(\frac{2m_e}{I} v^2 \right) \right], \qquad (1.3)$$

where A its relative atomic mass of target atoms, N_A the Avogadro number, M_u the molar mass constant and m_e is electron mass. In the Bethe theory, the atoms of material are characterized by the means of excitation potential I. The effect of nuclear stopping power is very small for swift ion and can be neglected in the high-velocity region.

3) Intermediate-velocity region, which is the intermediate area between the low and high velocities:

$$v_0 < v < v_m. \qquad (1.4)$$

Unfortunately there is no acceptable analytical formula to calculate energy losses of ion in intermediate-velocity and we have only experimental data. In general it can be concluded that velocity proportional energy loss has been in fact observed experimentally for most of common materials.

If the stopping power is known the distance traveled by ion in media can be determined by:

$$x(E)=\int_{E_0}^{E}\frac{d\varepsilon}{S(\varepsilon)}\quad . \tag{1.5}$$

Formula (1.5) is essential for analytical deep profiling. However, the main problem is to find the analytical form of the function *S(E)* which we need to integrate. Finite number of measured values is not sufficient for that purpose. Experimental values of stopping powers (*S*) for various ions with energy (*E*) in different media have been comprehensively given by ICRU49 (International Commision of Radiation Units and Measurements) and by SRIM – 2000 (Stopping and Range of Ions in Matter, Ziegler 2001).

The aim of our work is to introduce a simple mathematical model for the study of elemental deep profiles from experimental RBS data mainly in the intermediate-velocity region of ion.

2. SPLINE INTERPOLATION OF SRIM DATA

We start from a set of points [E_i, S_i], i = 1, 2, ... N, where E_i are values of energy and S_i represents corresponding stopping power measured experimentally (see points in the graph shown in the fig.1). These N points makes (N -1) intervals between them. It is necessary to know the function $S = S(E)$ to apply the formula (1.5) for the ion range determination. This function can be designed using quadratic spline interpolation [20-22] at which a piecewise continuous curve passing through each of poins is found. Two-point boundary value problem must be solved in this procedure. In this section we briefly describe procedure for determination of this curve in the form of a separate quadratic polynomial for each interval (each with its own coefficients).

We are looking for the quadratic polynomial in the next form:

$$S^{(n)}(E)=S_n=a_2^{(n)}E^2+a_1^{(n)}E+a_0^{(n)} \tag{2.1}$$

for n = 2,3,4,.... It can be considered that in the first interval (for $n = 1$, i.e. at the lowest energies of ion) mentioned function *S(E)* follows directly from LSS theory and it has a form:

$$S^{(1)}(E)=C\sqrt{E}\,. \tag{2.2}$$

where C is constant. It is necessary to determine the coefficients $a_0^{(n)}$, $a_1^{(n)}$, $a_2^{(n)}$ for polynomials (2.1) in all N-2 energy intevals (except the first interval). For this purpose we need 3(N-2) independent equations. The coefficients of the polynomials (2.1) must be determined such that the function *S(E)* to be continuous in all points [E_i, S_i] and derivative of this function in the mentioned points should be continuous too. Therefore if we use designations:

$$S^{(n)}(E_{n-1})=S_{n-1}\quad ,$$

$$S^{(n)}(E_n)=S_n\quad ,$$

$$\left(\frac{dS^{(n)}}{dE}\right)_{E=E_{n-1}}=D_{n-1}\quad , \tag{2.3}$$

following conditions must apply for each point n = 2,3,4,....N:

$$a_2^{(n)}E_{n-1}^2+a_1^{(n)}E_{n-1}+a_0^{(n)}=S_{n-1} \tag{2.4}$$

$$a_2^{(n)}E_n^2+a_1^{(n)}E_n+a_0^{(n)}=S_n \tag{2.5}$$

$$2a_2^{(n)}E_{n-1}+a_1^{(n)}=D_{n-1} \tag{2.6}$$

For the first point (n = 1), i.e. at the lowest measured value of energy E_1 next formulas can be written:

$$S^{(1)}(E_1)=S_1=C\sqrt{E_1}\,, \tag{2.7}$$

$$D_1=\left(\frac{dS^{(1)}}{dE}\right)_{E=E_1}=\frac{S_1}{2E_1}\,. \tag{2.8}$$

Formulas for any coefficients $a_0^{(n)}$, $a_1^{(n)}$, $a_2^{(n)}$ can be easily found from the system of equations (2.4), (2.5), (2.6):

$$a_2^{(n)}=\frac{\nu_n-D_{n-1}}{(E_n-E_{n-1})}\,, \tag{2.9}$$

$$a_1^{(n)}=D_{n-1}-2\kappa_n\{\nu_n+D_{n-1}\}\quad , \tag{2.10}$$

$$a_0^{(n)}=S_{n-1}-D_{n-1}E_{n-1}+\kappa_n\{(S_n-S_{n-1})\kappa_n-D_{n-1}E_{n-1}\} \tag{2.11}$$

where: $\nu_n = \left(\frac{S_n - S_{n-1}}{E_n - E_{n-1}} \right)$, $\kappa_n = \left(\frac{E_{n-1}}{E_n - E_{n-1}} \right)$

and derivative D_n can be written in the next form:

$$D_n = 2a_2^{(n)} E_n + a_1^{(n)}$$

Values of the stopping power for individual constituent in TeO_2-$PbCl_2$ glass structure was taken from SRIM software library. Next the Bragg`s rule of additivity was applied for the stopping power values in the glass structure determination. According to this rule for mixtures a good approximation is to compute the average stopping power weighted by the fraction of atoms (electrons) in each elements, i.e.:

$$\frac{1}{\rho}\frac{dE}{dx} = \sum_i \frac{w_i}{\rho_i}\left(\frac{dE}{dx}\right)_i$$

where w_i are weight fractions and ρ_i are densities of the of each element. The result is shown in the fig.1.

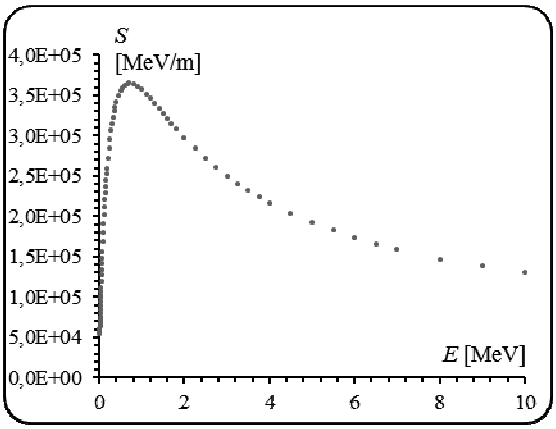

Fig. 1. Stopping power of H^{2+} in TeO_2-$PbCl_2$ glass determined from SRIM data using Bragg`s

Applying results (2.9), (2.10) and (2.11) in polynomials (2.1) and considering the expression (2.2) we get interpolation function *S(E)* in whole required energy interval.

The graph of this function in energy interval from 0 up to 2 MeV for He^{2+} ion in the structure of TeO_2-$PbCl_2$ glass is shown in the fig.2.

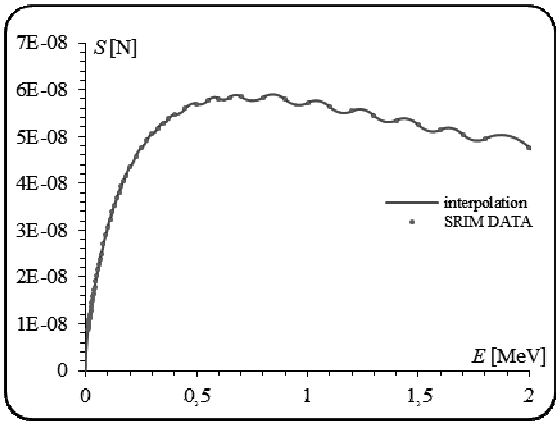

Fig. 2. Piecewise continuous smooth curve as a result of spline interpolation

3. RANGE OF ION PENETRATING INTO SOLIDS

Energy loss processes of ions in various media have been widely studied by a variety methods. The understanding of those processes is imperative in many areas of materials science, both in application and basic research. It is also very important in using practical analytical techniques such as ion beam analysis.

The energy losses of ion during transport in a material structure can be calculated using results presented in the previous section. The stopping power of ions in matter *S* is usually given for different energies of ion. If the function *S(E)* can be evaluated in the form (2.1.1) for any interval we have:

$$S^{(n)}(E) = -\frac{dE}{dx} = a_2^{(n)}E^2 + a_1^{(n)}E + a_0^{(n)} \qquad (3.1)$$

($n = 2, 3, 4, \ldots N$). Next equation follows from (3.1):

$$\int \frac{dE}{a_2^{(n)}E^2 + a_1^{(n)}E + a_0^{(n)}} = -\int dx\,. \qquad (3.2)$$

Three types of solutions of equation (3.2) can be found in different energy intervals. Two of them can be written in the form:

$$x^{(n)}(E) = x_{n+1} + \frac{2}{\xi^{(n)}}\left\{\chi\left[\eta^{(n)}(E_n)\right] - \chi\left[\eta^{(n)}(E)\right]\right\}. \qquad (3.3)$$

$\chi = \chi(y)$ is function of argument $y = \eta(E)$, where:

$$\eta^{(n)}(E)=\frac{\delta^{(n)}(E)-\lambda\xi^{(n)}}{\lambda\delta^{(n)}(E)+\xi^{(n)}},$$

$$\xi^{(n)}=\sqrt{\left|4a_2^{(n)}a_0^{(n)}-\left(a_2^{(n)}\right)^2\right|},$$

$$\delta^{(n)}(E)=2Ea_2^{(n)}+a_1^{(n)},$$

and λ is parameter. Equation (3.3) represents two types of solution of equation (3.2) which can be distinguished by means of parameter λ and charcter of function $\chi(y)$ as follows:

- The first type we have if $4\,a_2^{(n)}a_0^{(n)}-(a_1^{(n)})^2 > 0$. Parameter $\lambda = 0$ and function $\chi(y) = arctg(y)$ in this case.
- The second type we get if $a_2^{(n)}a_0^{(n)}-(a_1^{(n)})^2 < 0$. These solutions are characterized by parameter $\lambda = 1$ and function $\chi(y) = ln(y)$.
- More over there is third type of solution for special case $a_2^{(n)}a_0^{(n)}-(a_1^{(n)})^2 = 0$ having the simple form:

$$x^{(n)}(E)=x_{n+1}+\frac{2}{\delta^{(n)}(E)}\left\{\left(\frac{\delta^{(n)}(E_n)}{\delta^{(n)}(E)}\right)-1\right\}. \quad (3.4)$$

It should be noted that experimental values E_i and S_i (for $i = N, \ldots 2$) represent boundary conditions to the solving of equation (3.1) and different type of solution must be applied in each of intervals.

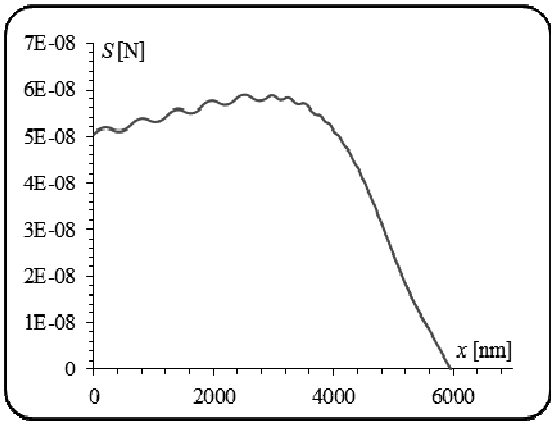

Fig. 3. Calculated Bragg curve for 1,7 MeV He^{2+} ion in the TeO_2-$PbCl_2$ glass

Distance traveled by ion in material structure must be determined step by step. Calculation must begin with $n = N$, next n gradually decreases by step 1 and values x_{n+1} always result from the calculation with previous n (i.e. from the calculation in the previous energy interval). In any case we must consider $x_{N+1} = 0$ and $E_N = E_0$ in (3.3) and (3.4) for $n = N$ because the traveled distance is equal zero at the moment when the ion with energy E_0 is entering into the material (E_0 is initial energy of ion). Finally in the first interval (i.e. for $n = 1$) the equation to be solved has the form (3.2) and next solution can be written at the lowest energies of ion:

$$x=x_2+\frac{2}{C}\left(\sqrt{E_1}-\sqrt{E}\right) \quad \text{where: } C=\frac{S_1}{\sqrt{E_1}} \quad (3.5)$$

Bragg curve of ion in the material structure can calculated using the algorithm based on presented results (for example see fig.3).

The importance of formulas (3.3), (3.4) and (3.5) is clear, E is the energy of ion after traveling a distance x in material. These results enable the analytical calculation of energy losses of ion which is slowing down in a material structure.

Above formulation for the stopping power calculating of He^{2+} ion in the TeO_2-$PbCl_2$ glass was used in intermediate-velocity region where we can rely only on a database of discrete values of stopping power in the evaluation of depth profiles. Results are shown in the fig.3.

4. PRINCIPLE OF ELEMENTAL DEPTH PROFILES CALCULATION

A typical problem in RBS analysis is the determination of the elemental composition of a sample as a function of the depth. Such depth profiles reconstruction from RBS data is an inversion problem to the problem of ion-beam and detector-induced energy spreads as well as energy-loss straggling and small-angle scattering effects. Recently this inversion problem is usually solved on the basis of Bayesian probability theory, which provides a method for quantifying and combining uncertain data and uncertain additional information [23, 24].

We assume, that depth profile only a single element is calculated from the clearly identified

peak in RBS spectrum. Principle of RBS depth profiles analysis is shown in fig.4. Let the angle of incident beam with sample`s normal is α and scattering angle is ϑ. Ion enters to the material and after traveling distance x_1 is reflected on atom (see fig.4). If the energy of ion just before the reflection is E, energy of reflected ion is E_d while:

$$E_d = kE\ , \qquad (4.1)$$

where k is kinematic factor determined by:

$$k = \left\{ \frac{M_{ion}\cos(\vartheta) + \sqrt{m_{at}^2 - M_{ion}^2 \sin^2(\vartheta)}}{M_{ion} + m_{at}} \right\}^2 \qquad (4.2)$$

Reflected ion gets back to the material surface after the passing distance x_2, where the ion with energy E_{meas} impacts to detector.

We note, that the energy of ion continuously changes along the paths x_1 and x_2 due to energy losses in the material structure.

We assumed that in intermediate-velocity region the correlation between traveled distance and ion energy $x = x(E)$ during the movement of ion in material can be estimated using discrete SRIM

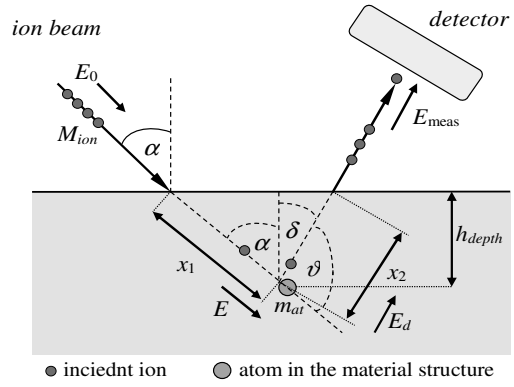

Fig. 4. Scheme illustrating the scattering of incident ion under the material surface

data by means of results (3.3) and (3.4). As can be easily found out, the depth of atom h_{depth} from which the ion was reflected can be written as (see fig.4):

$$h_{depth} = x_1 \cos(\alpha) = x_2 \cos(\pi - \alpha - \vartheta)\,. \qquad (4.3)$$

Conversion of measured energy E_{meas} to depth h_{depth} can be realized by means of equation (4.3) taking into account the fact that:

$$x_1 = x_1(E) \quad \text{and} \quad x_2 = x_2(E_{meas})\,. \qquad (4.4)$$

Calculated conversion curves obtained by iterative method are shown in fig.5 and fig.6.

As can be seen from mentione graphs, transformation of measured energy to depth could be approximated by a linear funcion in the near-surface area.

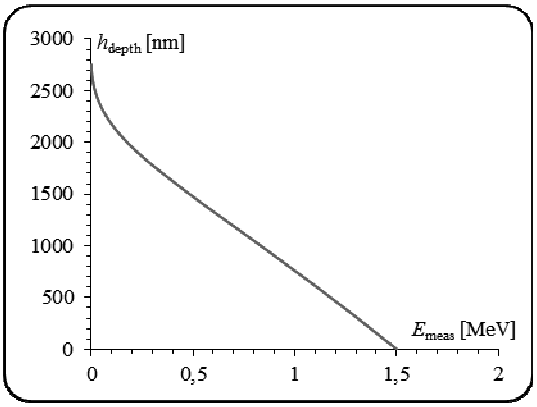

Fig. 5. Graph illustrating conversion of measured energy into depth calculated from interpolated SRIM data for 1,5 MeV He^{2+} ion scattered on Te atoms in TeO_2-$PbCl_2$ (80-20) target.

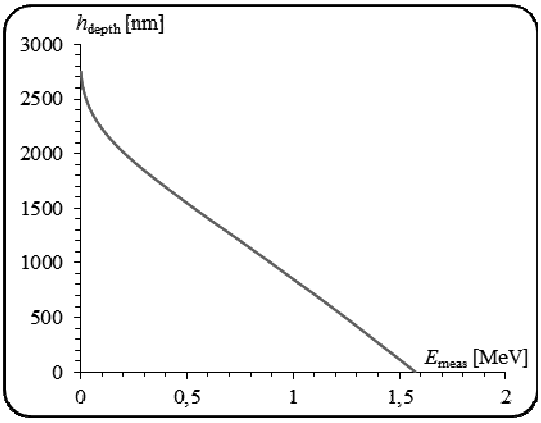

Fig. 6. Graph illustrating conversion of measured energy into depth calculated from interpolated SRIM data for 1,6 MeV He^{2+} ion scattered on Pb atoms in TeO_2-$PbCl_2$ (80-20) target.

Areal density of atoms in various depths under the material surface can be deduced from yeld of RBS spectra. Let N_{impact} is the number of ions incident on the material surface and N_{count} is nuber of scattered ions scanned by detector. In general the number of incident ions is not equal the nuber of ions registered by detector because not all ions from the applied beam is scatteder to the area of detector (i.e. to the angle ϑ). Number of ions scattered into a certain solid angle is

determined by scattering cross-section that can be written as [25] (in case of non-relativistic Coulomb type of scattering):

$$\frac{d\sigma}{d\Omega}=\gamma\frac{\left\{\sqrt{m_{at}^2-M_{ion}^2\sin^2(\vartheta)}+m_{at}\cos(\vartheta)\right\}^2}{m_{at}\sin^4(\vartheta)\sqrt{m_{at}^2-M_{ion}^2\sin^2(\vartheta)}} \quad (4.5)$$

where: $\gamma=\left(\frac{e^2}{8\pi\varepsilon_0}\right)^2\left(\frac{zZ}{E}\right)^2$.

Let the total number of ions applied on the target surface area S_0 during the RBS measurement is N_{impact} and $n^{(i)}$ is total number of atoms of i-th element in the structure of exposed area. Only some of applied ions are scattered on atoms of i-th element. From standard probabilistic rules follows that yeld from the i-th element in RBS spectrum can be written as:

$$N_{count}^{(i)}=N_{impact}\left(\frac{n^{(i)}}{S_0}\right)\frac{d\sigma}{d\Omega}, \quad (4.6)$$

$$\text{while: } \Gamma^{(i)}=\frac{n^{(i)}}{S_0}, \quad (4.7)$$

is just the areal density of i-th compound. If Q is the charge applied on the target surface (dose), i.e.:

$$N_{impact}=\frac{Q}{ze}, \quad (4.8)$$

applying (4.5), (4.6) and (4.7) next formula for the areal density of i-th compound can be found:

$$\Gamma^{(i)}=\left(\frac{8\pi\varepsilon_0}{Ze}\right)^2\Lambda\left(\frac{E^2}{zeQ}\right)N_{count}^{(i)}, \quad (4.9)$$

where: $\Lambda=\frac{m_{at}\sin^4(\vartheta)\sqrt{m_{at}^2-M_{ion}^2\sin^2(\vartheta)}}{\left\{\sqrt{m_{at}^2-M_{ion}^2\sin^2(\vartheta)}+m_{at}\cos(\vartheta)\right\}^2}.$

Conversion of yield in RBS spectra to areal density scale can be simply realized by means of formula (4.9) taking into account the fact that:

$$h_{depth}=h_{depth}(E_{meas}), \quad (4.10)$$

5. CONCLUSIONS

The depth profiling of atoms in composites using discrete data from SRIM database was treated analytically in the contribution. Major motivation of our work was to verify the applicability of simple analytical algorithm for quantitative depth profiling from RBS data. Attention was devoted to the suitable processing of experimental RBS signal consisting of ions scattered close to the surface of the investigated sample using SRIM database. RBS signal itself relates directly to the composition of atoms at any specific depth in the sample. The quantitative evaluation of depth profiles requires the conversion of a measured energy of ions versus yield of RBS signal intensity into a distance from the original surface versus true areal density of atoms. Basically, this conversion procedure comprises the evaluation of the energy of ion after traveling a distance x in the material structure using discrete stopping power data from SRIM database. Data processing formulas were presented, starting with a very simple approximation of stopping power dependence from energy using the spline interpolation the SRIM data. The basic mathematical procedures for the quantitative depth profiling were stated and processed data points were illustrated for two selected profiles in TeO_2-$PbCl_2$ glass surface. It can be assumed, that possible errors due to oscillations of function $S(E)$ obtained by spline interpolation (see fig.3) are compensated by the integrating in (1.5) and graphs of correlation functions between depth and measured energy show no such deviations (see fig.5 and fig.6).

In conclusion, we analytically solved the problem that is usually investigated using statistical algorithms in order to simplify and accelerate data processing. One can easily understand that there is a correlation between the energy of ion detected after scattering and depth of the scattering centre if the energy of the ion penetrating into material changes. This correlation was mathematically demonstrated in our contribution. Indeed, expressions (3.3), (3.4), (3.5) and (4.3) allow one to investigate this correlation. As an illustration we have shown results for ^{126}Te and ^{206}Pb atoms in the surface of TeO_2-$PbCl_2$ glass. This specific case of material have used here because of its

complexity but we believe that presented procedure can be applied also for any materials.

6. ACKNOWLEDGEMENTS

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Effect of the Arrival Frequency Process on the Link Performance Function of a Signalized Intersection

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Abstract

Traffic flow theories generally use two different kinds of traffic flow – serving time (shortly link performance) function: the Beckman type (power function) and the Nesterov de Palma type (step function). Nevertheless, the actual link performance functions can be unique in every cases, depending on the characteristics of the specific road or intersection. It is well known that the random process of the arrival frequency of the vehicles affects considerably the link performance function of a signalized intersection. In the present work we investigate the specific effect of the long period (8-15min) fluctuation property the arrival frequency random process on the link performance function, especially on its theoretical (Beckman or Nesterov de Palma type) character. We determined the link performance functions of a straight one-lane road with a signalized intersection at the end by a traffic micro-simulator. Different periods of the fluctuation of the arriving frequency were applied. It was found that the long term fluctuation affects the character of link performance function considerably.

Keywords: signalized intersection, link performance function

1. INTRODUCTION

One purpose of the traffic-flow analysis is to obtain a reliable mathematical model that helps the traffic control or urban road-planning. The so called “traffic assignment problem” (i.e. the calculation of the flow rates on the road-network) has two theoretical approaches: calculating the “User Equilibrium” or calculating the “System Optimum” according to the first and the second Wardrop’s Principle, respectively [1].

The solution of traffic assignment problem relies heavily on the so called “link performance function” [2], that determines the travelling time on a specific road (i.e. link) as a function of the traffic load, which is given by the passing vehicle units per time unit (generally unit/hour). Regarding the link performance function, two basic model became popular: the Beckmann type function [3] and the Nesterov & de Palma function [4]. In the Beckmann model the link performance function is monotonous increasing and convex, generally a power-function. In the Nesterov de Palma model the link performance function is a step-function, that is constant when the traffic load is below the maximal road-capacity (or simply road capacity) and jumps to infinity (or a very high time-value) when the load reaches the road capacity. This latter obviously makes the traffic assignment problem easier to solve while the Beckmann is generally considered to be more realistic.

Figure 1 shows the Nesterov de Palma function and three different Beckmann type functions (labelled by BPR 1, 2, and 3 see ref. [5]) as an illustration.

However, the real link performance function of a specific road can be dependent on numerous

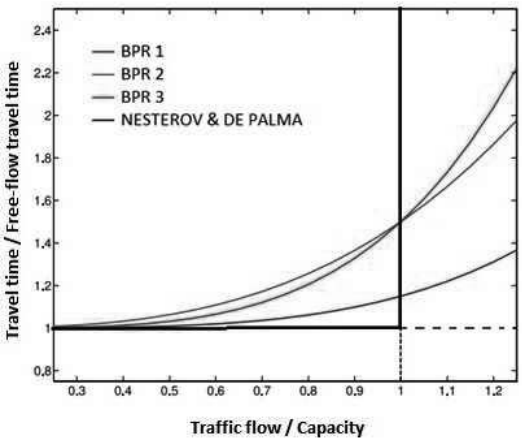

Fig. 1. The Nesterov de Palma link performance function (black line) and three Beckmann type link performance functions (BPR 1, 2 and 3)

static parameters and, among these, on the arrival frequency random process. Especially it is true when the road ends in a signalized intersection. The specific type of the link performance function affects considerably the solution of the traffic assignment problem as it was shown by Chudak et al. [6]. In order to determine the link performance function, beyond measurement, numerous theoretical or simulation method can be used [7,8,9,10].

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The aim of the present work is to investigate the effect of the random process of the arrival frequency on the link performance function. To be more specific, we use arrival frequency processes, where the traffic load has a considerable long period fluctuation in time, which often happens in real traffic. In the next section the mathematical details are given. Section 3 introduces the results and in the last section we conclude.

2. DETAILS OF THE MATHEMATICAL MODEL

The arrival frequency distribution in case of a signalized intersection is supposed to be Poisson or some generalized Poisson with more than one parameter (see for e.g. [11] or [12]). In this work we introduce a special Poisson based distribution that has a fluctuation of the traffic load with a time period much longer than the traffic-lamp cycle. We will work with traffic lamp cycle of *60s*, so the arrival time frequency, denoted by *f(i)*, is measured as the arrival events under *60s* at the *i*th cycle. If we suppose a simple one parameter Poisson distribution, then *f(i)* is given by:

$$f(i) = P_{\lambda}(i) \tag{1}$$

where $P_{\lambda}(i)$ is the *i*th random number from a Poisson series with λ parameter. Here the index i measures the minutes. If altogether N unit vehicle (passenger car) arrives under T time, then

$$\lambda = N/T \tag{2}$$

We define the special fluctuated arrival frequency random process as:

$$f(i,p) = P_{G(\lambda,\sigma)(p)}(i) \tag{3}$$

where $G(\lambda,\sigma)(p)$ is the *p*th random value of a Gaussian distribution series with λ mean and σ variance, and this Gaussian random number steps to the next value at the end of a T_p period. In other words, the λ parameter of the Piosson process changes once in every T_p minute period, so this introduces a fluctuation in addition of the simple Poisson process with a time period T_p. Figure 2 shows an example of such a fluctuated Poisson random sequence with the parameters:

$$\sigma/\lambda = 0.25, \quad T_p = 8\,\text{min} \tag{4}$$

Note that if the σ parameter (and so the σ/λ ratio) tends to zero, then this fluctuated Poisson sequence crosses over to be a simple Poisson sequence with parameter λ. So the random process introduced above can be considered as a "kind of" generalized Poisson process with a

limiting case of a simple Poisson at $\sigma=0$. This, however, is not the same as the known "Generalized Poisson" random process [12]. In that case it is not possible to introduce such fluctuation in the λ parameter with arbitrary weight and period.

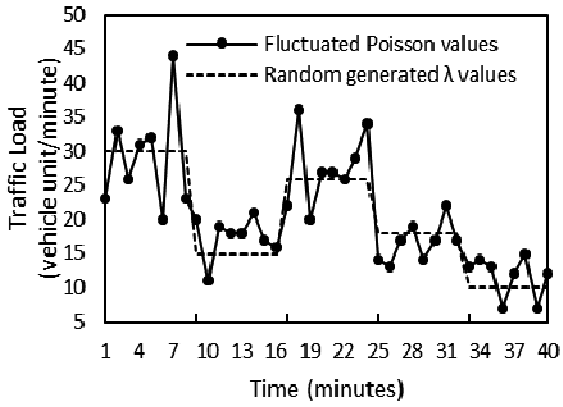

Fig. 2. Illustration of the fluctuated Poisson random sequence. Dashed line shows the values of the λ parameter that changes in every 8 minutes.

3. SIMULATION AND RESULTS

In order to examine the effect of such a long period random fluctuation we apply a self-developed and Intelligent Driver Model based traffic micro-simulator [9]. The simulation context is a simple one lane road of length *500m* controlled by a traffic-lamp, with *60s* cycle and *40s* green time for the road at hand. Figure 3 shows simulator snapshots of the signalized intersection (A) and a road-segment with a row of unit vehicles (B).

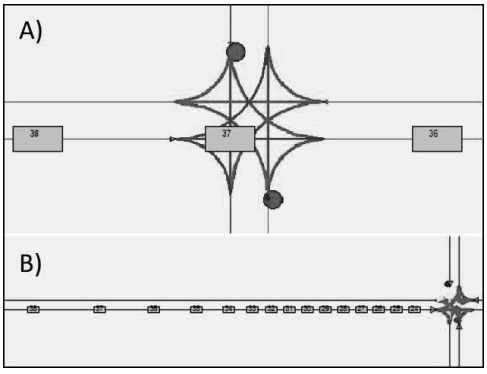

Fig. 3. Illustration of the examined traffic context. The parts A) and B) show the intersection at a closer view and a bigger part of the context with a row of the vehicles. The lanes are indicated by blue lines, the grey shapes are the unit vehicles.

In order to obtain a brief picture on the effect of the λ parameter fluctuation we ran *T=32400s* (9 hours) long simulations in the above context with the parameter set:

$$\begin{aligned} &\sigma/\lambda = \{0;\, 0.25\}, \\ &T_p = \{480s,\, 900s\}, \\ &N = \{900, 1800, 2520, 2880, 3240, 3600, 3780\}. \end{aligned} \tag{5}$$

When $\sigma=0$, the experiment yields the simple Poisson case, so we use this as a control for the fluctuated case. The numbers of the vehicles (N) determines the traffic load, so they were chosen so that we obtain data distributed in the load range under the road capacity but more data near the critical point of the capacity limit.

The experiments have shown, that the capacity limit of the applied road-intersection context is *21 vehicle-unit/min* (that is *21/60 vehicle-unit/s*), and in sketching the link performance function we used the relative traffic load value that is the ratio of the actual traffic load divided by the road capacity limit (*21 unit/min*). In this way the capacity limit is *1* on the graph, similarly to the graph given in Figure 1. The results are shown in Figure 4.

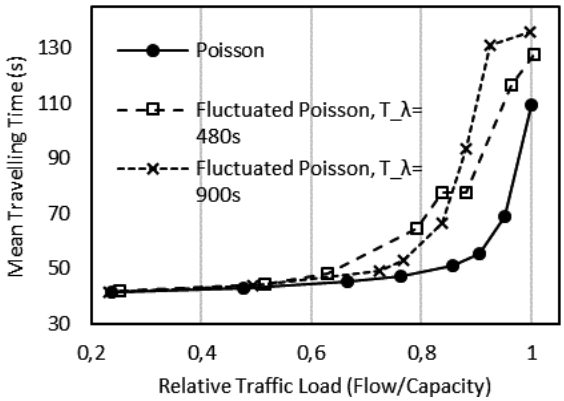

Fig. 4. The link performance functions of the experimental context by using a simple Poisson and two fluctuated λ Poisson random processes.

It can be seen from the results that all three link performance function are of a Beckmann type, however, the graph of the control process, i.e. the simple Poisson process, is much closer to the Nesterov de Palma function than the other two. In other words, the fluctuation property in the λ parameter results in a more forceful

Beckmann character of the function graph. Nevertheless, the effect of the T_λ interval parameter is not clear yet, since the two graphs, with $T_\lambda = 480s$ and $T_\lambda = 900s$, are not separated distinctly, and it is hard to decide which has more pronounced Beckmann character. Probably, this is due to the short simulation times that causes statistical uncertainty in the measured mean travelling times. In the case of these functions we need much longer simulation runs to reduce this uncertainty.

4. CONCLUSIONS

In the present work it was found that the long period fluctuation affects the character of link performance function considerably. In the case of a simple Poisson process, without long period fluctuation, the link performance function is of a Becmann type, but quite close to the Nesterov de Palma function type. While the link performance functions obtained by applying a long period (8-15min) fluctuation of the λ parameter of the Poisson process have a much stronger Beckmann character.

5. ACKNOWLEDGEMENTS

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Sintering of Slip Cast Composite Al_2O_3-ZrO_2 Ceramics

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Abstract

Slip casting method can be used for forming monolithic and composite ceramics, in which a stable aqueous suspension of ceramic particles is poured into a plaster mould. Zirconia-toughened alumina composite ceramics possess many attractive properties such as high-temperature mechanical strength, wear resistance, low thermal conductivity and good thermal shock resistance. Compared to monolithic alumina ceramics, composite Al_2O_3-ZrO_2 ceramics have enhanced fracture toughness and flexural strength due to the embedded zirconia grains in the alumina matrix. In this paper, water-based suspensions with a total of 70 wt. % solid phase content (monolithic Al_2O_3 and composite Al_2O_3-ZrO_2 ceramic suspensions) were prepared. The solid phase of composite ceramic suspensions consisted of either 1 or 10 dry weight base (dwb) % addition of zirconia (ZrO_2) powder, and the rest was alumina powder. The used zirconia (ZrO_2) powder was partially stabilized with the 3 mol % yttria (Y_2O_3). A dispersant (Dolapix CE 64) and a binder (polyvinyl alcohol - PVA) were added for the stabilization of water-based suspensions. The stability of 70 wt. % monolithic (Al_2O_3) and composite (Al_2O_3-ZrO_2) ceramic suspensions was evaluated by rheological measurements and sedimentation tests. Suspensions were homogenized in a planetary ball mill and green bodies were prepared by slip casting of stable suspensions in a plaster mould. After the sintering, the density of the sintered monolithic and composite ceramic samples was measured and compared.

Keywords: alumina - zirconia composite ceramics, slip casting, stability, rheology

1. INTRODUCTION

The demand for new and improved ceramic materials is constantly growing, especially over the last few decades. Although monolithic ceramics have a wide application scope, some features such as brittleness and a low damage tolerance make them inadequate for some applications. Better features can be achieved by embedding ceramic fibres or grains in a ceramic matrix to obtain a ceramic composite with improved properties [1].

The addition of zirconia grains (ZrO_2) to alumina matrix forms zirconia-toughened-alumina (ZTA) ceramic. Engineering applications of zirconia were made possible by the discovery of the stabilization of the tetragonal phase using either magnesium oxide (MgO) or yttrium oxide (Y_2O_3) [2]. In addition to high hardness and chemical stability of alumina, ZTA ceramics are characterized with high fracture toughness due to zirconia's transformation of the tetragonal phase to monoclinic phase [3]. These improved properties such as high mechanical strength, wear resistance, high flexural strength and fracture toughness extend the application scope of ZTA ceramics [4]. It has been used for different cutting tools, biomedical implants, dental ceramics, structural ceramic parts and lately armour materials [5,6].

The transformation of the tetragonal phase to monoclinic phase in stabilized zirconia acts as a dissipative mechanism for fracture energy. This dissipative fracture energy is due to volume expansion during the tetragonal to monoclinic phase transformation [7]. When a crack appears

in the material, the grains next to the crack transform into monoclinic phase. The changes in volume and in shape of the crystal cells take place on account of the elastic stresses during the propagation of the crack. All these processes lead to an increase in toughness of the ceramic material [2].

Different technologies, such as dry-pressing, tape casting, pressure casting, slip casting or spraying can be used to produce composite ceramics. All of these forming methods start with a suspension of ceramic powder, water and additives [8]. Slip casting is a colloidal technique used for the consolidation of the ceramic powder from an aqueous suspension. The slip, i.e. the suspension, is poured into a porous mould which withdraws water from the slip producing a green body ready for sintering. Slip casting is a widely used inexpensive process suitable for producing both monolithic and composite ceramics even for complex geometries. However simple this technique may be, it requires adequate understanding of colloid suspensions and their behaviour [9,10]. In order to obtain a material with high green density and microstructural homogeneity, different casting parameters must be properly adjusted such as suspension viscosity and stability, as well as the suspension composition. To achieve low suspension viscosity, but also high green and sintered density, various additives are added to the suspensions, such as the dispersants and binders [11]. The addition of dispersants eliminates the powder's tendency to agglomerate due to the attractive intra-particle van der Waals forces. The obtained slip has low viscosity with high solid loading to ensure high green density and homogeneous microstructure [12].

In this paper, water-based suspensions with a total of 70 wt. % solid phase pure Al_2O_3 as well as mixture of Al_2O_3 and ZrO_2 powder were studied. Two composite ceramics were prepared with 1 and 10 dwb % of the 3 mol % yttria-partially stabilized zirconia (ZrO_2) powder. A dispersant (Dolapix CE 64) and a binder (PVA) were added for the stabilization of water-based suspensions. The stability of 70 wt. % monolithic Al_2O_3 and composite Al_2O_3 - ZrO_2 ceramic suspensions was evaluated by rheological measurements and sedimentation tests. Suspensions were homogenized in a planetary ball mill and green bodies were prepared by slip casting of stable suspensions in a plaster mould. After the sintering at 1600 °C, the density of the sintered monolithic and composite ceramic samples was measured and compared.

2. MATERIALS AND METHODS USED FOR RESEARCH

2.1. Preparation of monolithic alumina and composite alumina - zirconia ceramic suspensions

Monolithic alumina suspensions were prepared with a total of 70 wt. % solid phase, and composite alumina - zirconia suspensions with 1 and 10 dwb % addition of the 3 mol % yttria-partially stabilized zirconia (ZrO_2) powder (SkySpring Nanomaterials, Inc., USA). High-purity Al_2O_3 powder was used, with the average particle size 300-400 nm (Alcan Chemicals, USA). A commercial carbonic acid based polyelectrolyte dispersant Dolapix CE 64 (Zschimmer & Schwarz Chemie GmbH, Germany) and binder PVA (polyvinyl alcohol, Sigma Aldrich, USA) were used to stabilize highly concentrated alumina and alumina - zirconia suspensions. The optimal amounts of the dispersant (Table 1) were determined in preliminary experiments.

The binder (PVA) was dissolved in deionised water at a temperature of 60 °C. The optimal amounts of the dispersant (Table 1) were added to the solution of the binder and water and added into the grinding jar of the planetary ball mill. After that, 70 wt. % of dry ceramic powder was added into the grinding jar. Ten alumina balls were used for the mixture homogenization, which lasted for 90 minutes at a speed of 300 rpm. Alumina balls were separated from the suspension after the homogenization using a sieve. The suspension underwent an ultrasonic

treatment for 15 min in an ultrasonic bath – Bransonic 220 (Branson Ultrasonics Corp., USA) to remove the air bubbles and achieve better homogeneity.

2.2. Rheological analysis of ceramic suspensions

Rheological properties of ceramic (monolithic and composite) suspensions were determined using a rotational viscometer DV-III Ultra (Brookfield Engineering Laboratories, Inc., USA) in a small sample chamber with spindle SC4-18. Pre-shearing lasted for 2 min at a shear rate of 100 s^{-1}. The shear rate was gradually increased from 0.1 to 180 s^{-1}, and then reduced back to 0.1 s^{-1}. The shear rate increase/decrease interval was divided in 50 equal time frames, which lasted for 3 seconds each. Rheological measurements were conducted just before each shear rate change.

2.3. Sedimentation tests

Aqueous ceramic suspensions (monolithic and composite) with 20 wt. % of dry solid phase were prepared with the corresponding amounts of the dispersant and the binder (Table 1). The pH value was adjusted using 0.1 M HCl, 0.1 M NaOH and the pH-meter FE20/EL20 (Mettler Toledo GmbH, Switzerland). 14 ml of suspensions, each with a different pH value (from 2 to 12) were poured into test tubes and set aside on a stand. The ceramic powder will remain dispersed in a stable suspension, while in an unstable suspension the ceramic powder will settle on the bottom of the test tube. Sediment volume was recorded after 1 h, 24 h, 72 h and 7 days for each suspension.

Table 1. Composition of prepared ceramic suspensions

Suspension	Dry powder content, wt.%	Composition of ceramic powder	Dispersant content, wt.%	Binder content, wt.%
1	70	100 % Al_2O_3	0.2	0.5
2	70	99 % Al_2O_3 + 1 % ZrO_2	0.3	0.5
3	70	90 % Al_2O_3 + 10 % ZrO_2	1	0.5

2.4. Preparation and sintering of ceramic green bodies

Production of ceramics by slip casting method involves pouring of highly concentrated water-based slip (suspension) into a plaster mould. To produce ceramic green bodies, water is absorbed by the mould through capillary action. This way, dense cast form is obtained which minimizes shrinkage in the final sintering process.

After 24 hours, green bodies were removed from plaster moulds and dried at 100 °C for 1 hour. Finally, dried green bodies were grinded and polished to form the desirable shape. Shaped green bodies were then sintered at 1600 °C in an electric furnace (Nabertherm P310, Germany). Sintering process was carried out as follows: 1 °C min^{-1} to 600 °C, with holding time of 1 hour; then 3 °C min^{-1} to 1600 °C. To complete the sintering process, samples were held for 2 hours at a temperature of 1600 °C after which they were furnace cooled to room temperature. Monolithic alumina ceramics and composite alumina – zirconia ceramics prepared by above described process are shown in Figure 1.

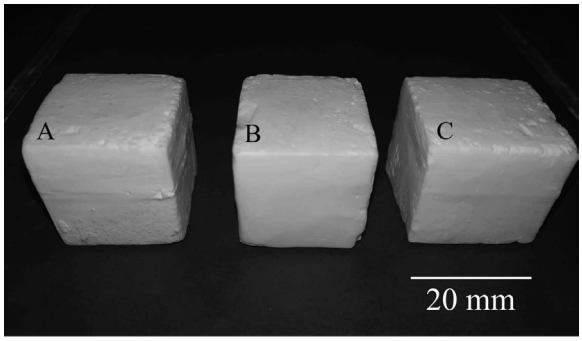

Fig. 1. Sintered ceramic samples: (A) 100% Al_2O_3, (B) 99% Al_2O_3 + 1% ZrO_2, (C) 90% Al_2O_3 + 10% ZrO_2

2.5. Density measurements

The density of the sintered samples was measured using a laboratory scale with Density Kit MS-DNY-43 (Mettler Toledo GmbH, Switzerland). Sintered samples were weighed, first in the air and then in a liquid (distilled water) of known temperature. The density is calculated by a computer program according to the ASTM C373-88 (Standard Test Method for Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products, Ceramic Tiles, and Glass Tiles). The density is defined according to the standard by the equation:

$$V = \alpha \frac{A - B}{\rho_0 - \rho_L} \quad (1)$$

where:

V – sample volume, cm^3,

α – correction factor (α =0.99985),

A – sample mass in air, g,

B – sample mass in liquid, g,

ρ_0 – liquid density, g cm^{-3},

ρ_L – air density, g cm^{-3} (ρ_L=0.0012 g cm^{-3}).

3. RESULTS AND ACHIEVEMENTS

3.1. Rheological flow curves

Rheological flow curves show the dependence of shear stress (τ) on viscosity (η) as well as on shear rate (γ), and can be used for predicting the nature of interactions among particles in the suspension. The alumina and alumina - zirconia suspensions flow curves are shown in Fig. 2.

The obtained results show that the suspension viscosity decreases with increasing shear rate (Figure 2A), that is, all suspensions show typical pseudoplastic behaviour, characteristic for non-Newtonian fluids [13]. Figure 2B shows that the shear stress increases with the increasing shear rate for all suspensions, which also confirms the previous statement. The addition of zirconia powder increases the viscosity and the shear stress.

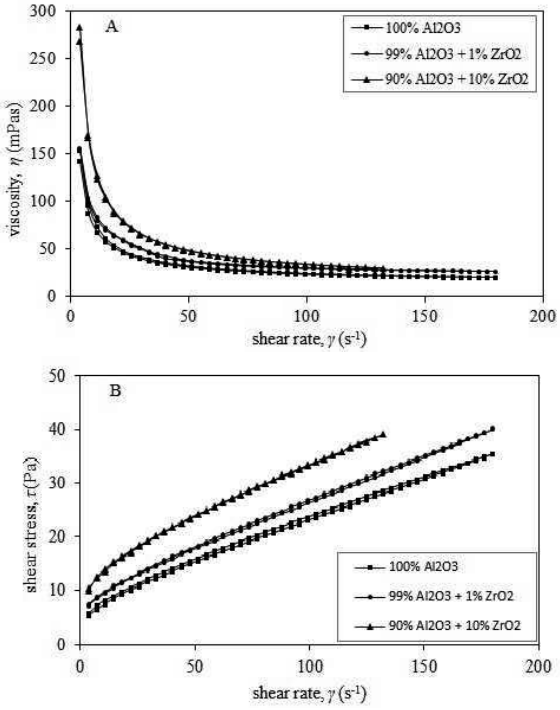

Fig. 2. Flow curves: (A) viscosity (η) vs. shear rate (γ), and (B) shear stress (τ) vs. shear rate (γ)

3.2. Sedimentation tests results

Values of sediment volumes at different pH after 1 h, 24 h, 72 h and 7 days of sedimentation are shown in Figure 3A for the alumina suspensions without the addition of zirconia powder. It is visible that the alumina suspensions are stable in acidic (2-5) and alkaline (8-12) pH region during the first hour. After 7 days phase separation is visible throughout the studied pH values.

Values of sediment volumes at different pH after 1 h, 24 h, 72 h and 7 days of sedimentation for the alumina suspensions with the addition of 1 dwb % of zirconia powder are shown in Figure 3B. During the first few hours, alumina - zirconia suspension is stable in the acidic (pH 2-4) and alkaline (pH 7-12) region. The pH region of stability is shifted to the left with the addition of zirconia powder. Phase separation is also visible after 72 hours.

Values of sediment volumes at different pH after 1 h, 24 h, 72 h and 7 days of sedimentation for the alumina suspensions with the addition of 10 dwb % of zirconia powder are shown in Figure 3C. It is noticeable that the alumina - zirconia suspension is stable only in the neutral

and alkaline (6-12) pH region. The pH region of stability is shifted even more to the left with the increase in amount of the added zirconia powder.

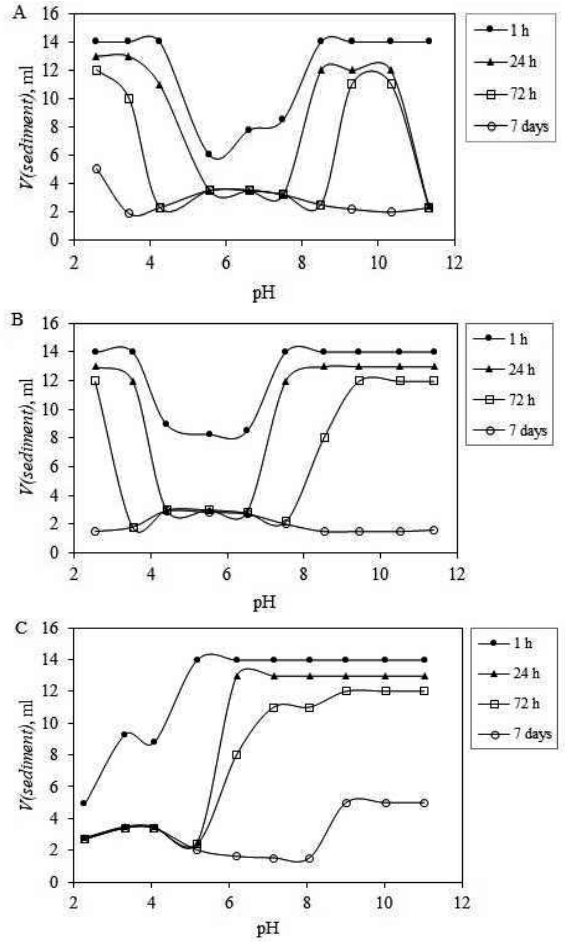

Fig. 3. Values of sediment volume at different pH of ceramic suspensions after 1 h, 24 h, 72 h and 7 days of sedimentation: (A) 100% Al_2O_3, (B) 99% Al_2O_3 + 1% ZrO_2, (C) 90% Al_2O_3 + 10% ZrO_2

3.3. Density measurements results

The results of the density measurements showed that the density of monolithic Al_2O_3 ceramic is 91.4 % of the theoretical alumina density (ρ_t = 3.986 g cm^{-3}), Table 2. The addition of the zirconia powder to alumina significantly increased the density of the sintered ceramic samples. The density of the composite ceramic with 99% Al_2O_3 and 1% ZrO_2 was 94% of the theoretical density (ρ_t = 3.999 g cm^{-3}), whereas the composite ceramic with 90% Al_2O_3 and 10% ZrO_2 was only 89.4% of the theoretical density (ρ_t = 4.172 g cm^{-3}).

Table 2. Density (ρ) of the sintered samples

Sample	ρ, g cm^{-3}	ρ_t, %
100% Al_2O_3	3.637	91.4
99% Al_2O_3 + 1% ZrO_2	3.759	94
90% Al_2O_3 + 10% ZrO_2	3.729	89.4

4. CONCLUSIONS

In this paper, water-based suspensions with a total of 70 wt. % solid phase (monolithic Al_2O_3 and composite Al_2O_3 - ZrO_2 ceramic suspensions) were prepared. Composite Al_2O_3-ZrO_2 ceramic suspensions were prepared with 1 and 10 dwb % addition of the 3 mol % yttria-partially stabilized zirconia (ZrO_2) powder to investigate the effect of zirconia addition on density of the sintered ceramic samples.

The stability of 70 wt. % monolithic Al_2O_3 and composite Al_2O_3-ZrO_2 ceramic suspensions was evaluated by the rheological measurements and the sedimentation tests. The rheological measurements showed that the addition of zirconia powder increases the viscosity and the shear stress of ceramic suspensions. The pH region of the stability of the prepared suspensions is shifted to the lower pH values with the increasing amount of zirconia powder.

The density of the sintered monolithic and composite ceramic samples was measured and compared. The results of the density measurements showed that the addition of zirconia powder to alumina increases the density of the sintered ceramic samples. The density closest to the theoretical one was observed for the composition of 99% Al_2O_3 + 1% ZrO_2. Although the addition of zirconia powder increased the density of ceramic samples, it is still lower that the theoretical one. Therefore, it must be considered to add various additives or to modify the sintering process to further increase the density.

5. ACKNOWLEDGEMENTS

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IP-2016-06-6000: Monolithic and Composite Advanced Ceramics for Wear and Corrosion Protection (WECOR).

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Approximation of the On-state Probability of Electrical Appliances by Radial Basis Function Neural Network

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Abstract

Recently bottom-up electricity consumption models has been come to the fore, since measuring appliance level consumptions has become possible by smart metering. Bottom-up models form a basis to an alternative way of predicting the consumption of a given (small or large) population of appliances/consumers. Increasing the accuracy of the prediction results in higher efficiency of the electricity grid, because peak consumption could be shaved while consumption valleys can be filled (assuming partly controllable appliances). Since the balance between production and consumption (which is a crucial issue regarding the electricity grid) can be achieved by scheduling, more accurate consumption predictions results in more efficient scheduling. The lack of above mentioned balance results overproduction or overconsumption. To govern electricity consumption, we suppose a bottom-up probability based consumption admission control algorithm, which was recently investigated by the authors. However the probability based admission algorithm needs the on-state probability of all the appliances connected to the smart meter. The main challenge here, that the probability of consumption is non-stationary and depends on other non-electrical variables as well, such as presence of the owner, outdoor temperature, solar power, etc. As a result, the problem of real-time estimation of the statistical parameters of the appliances can be formulated as a multidimensional function approximation task, for which Radial Basis Function Neural Network are known as proven in this paper as efficient tool.

Keywords: consumption admission control, radial basis function neural networks

1. INTRODUCTION

One of the main tasks of electricity service providers is satisfying perfect balance between supply and demand. On the other hand, there is a high social pressure to increase the percentage of renewable energy resources in the electrical energy supply. The control of the supply side is difficult in many cases because of the large time constants of the basic fossil and nuclear plants; the only solution is to use economically inefficient extra gas and oil generators. Hence, an alternative way to keep the balance is to control the demand side. This concept is referred to as Demand Side Management (DSM) [1] in the Smart Grid literature. There exist many DSM methods, for instance night-time heating with load switching, time-of-use pricing and direct load control. In general DSM covers all the activities or programs undertaken by service providers to influence the amount or timing of electricity use. The residential sector represents an important part of the electricity demand and contains flexible appliances in high number. The amount of consumption involved in direct control can eliminate the error between daily prediction based generation and actual demand.

In this paper we are investigating appliance level statistical parameter estimation based on an RBF neural network as part of our previously proposed Consumption Admission Control algorithm [2,3]. Smart metering enable us to collect appliance level statistics, hence we can use this additional information in our method. Appliance level statistical parameter estimation means the extraction of models describing how appliances are used by residents. The aim of the paper is developing an RBF approximator which can estimate the current value of statistical descriptors of a given appliance. In this paper we focus on the non-stationary on-state probability of a single appliance. The main challenge here, that the on-state probability depends not only on the time of day, but also on other non-electrical parameters, such as indoor and outdoor temperature, solar power, presence of the owner, etc. This function is multidimensional, unknown, and furthermore can be different for different appliances. As a result automatic function approximation tool is needed to estimate the underlying probabilities. The focus of the paper is the approximation of the on-state probability based on time of day and presence of the owner as input parameters. The number of input parameters can be increased without any problem, the reason of using only two parameters in this paper is the limitation in the given database we could use. Our concept is depicted by Figure 1.

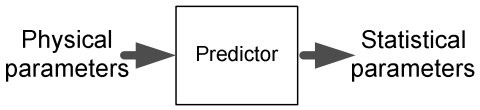

Fig. 1. The approximator structure

2. MATHEMATICAL MODEL

From a mathematical point of view there is an unknown mapping between some environmental parameters (such as time of days, day of week, temperature, humidity, light conditions, occupancy etc.) and the statistical descriptors of the corresponding power consumption time series model (e.g. probability distribution function, Markov state-transition matrix, etc). This unknown mapping can be interpreted as an unknown function which can be approximated by a proper tool. The approximator has to be optimized based on a training set $\tau^{(K)} := \{(\mathbf{u}_k, \mathbf{z}_k), k = 1,...,K\}$. The unknown function is denoted by $\Psi(\mathbf{u})$, where $\mathbf{z}_k = \Psi(\mathbf{u}_k)$. Here variable $\mathbf{u}$ represents the environmental parameter vector, whereas variable $\mathbf{z}$ corresponds to the statistical parameter vector. The underlying task is to develop an algorithm $F(\mathbf{u}, \mathbf{w})$, which is able to capture $\Psi(\mathbf{u})$ with a given level of accuracy. Here vector $\mathbf{w}$ represents the free parameters of the approximator which can be tuned to fit $F(\mathbf{u}, \mathbf{w})$ to $\Psi(\mathbf{u})$ over the training set $\tau^{(K)}$.

By using instead of $\Psi(\mathbf{u})$ one must make sure that it has the necessary (i) representation-, (ii) learning- and (iii) generalization capabilities needed to approximate $\Psi(\mathbf{u})$. In order to come to grips with the tasks listed above, the Radial Basis Function network implementations of $\mathbf{F}(\mathbf{u}, \mathbf{w})$ will be investigated (since the universal approximator property and off-line learning capability of this method).

2.1. Radial Basis Function

Radial Basis Function networks are one-hidden-layer neural networks. All the processing elements (neurons) of the first (hidden) layer get the whole input vector. The input vector is compared to the centre point of the given neuron, and a nonlinear function of this distance (in the Euclidean sense) gives the output. In the

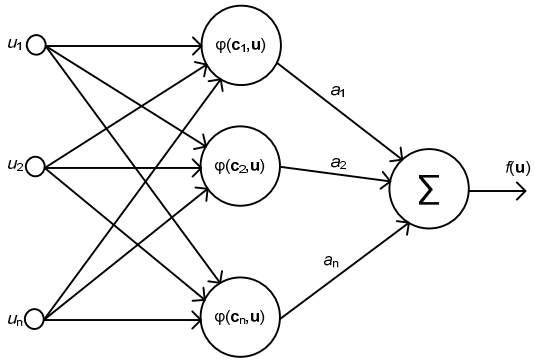

Fig. 2. The RBF structure

second layer only one processing element makes a weighted sum of the outputs of the hidden layer neurons. The formulae that describe the RBF network:

$$f(\mathbf{u}) = \sum_{i=1}^{K} a_i \varphi(\mathbf{c}_i, \mathbf{u}) \quad (1)$$

$$\varphi(\mathbf{c}_i, \mathbf{u}) = exp\left(-\frac{\|\mathbf{c}_i - \mathbf{u}\|^2}{2\sigma_i^2} \right) \quad (2)$$

where $\mathbf{u}$ is the input vector, K is the number of neurons in the hidden layer (the number of radial basis functions), $\varphi(.)$ is called the radial basis function, which is mostly the Gaussian function as indicated above, and σ is called the width parameter.

The complexity of the network

The complexity of the network is determined by the number of hidden layer neurons, i.e. the number of the basis functions of different centre points. The approximation is the weighted sum of the basis function values for a given input.

Setting the width parameters

The width parameters of the network can be different for all the basis functions, however they are mostly set to be equal. The approximation quality is not too highly dependent on the width parameters which are mainly set by the following empirical nearest-neighbour rule [5]:

$$\sigma = \frac{1}{K} \sum_{i=1}^{K} \|\mathbf{c}_i - \mathbf{c}_j\| \quad (3)$$

where c_j is the nearest neighbour of c_i in the Euclidean sense.

Training of the network

The training of the network is carried out based on a training set, i.e. some points of the function to be approximated are known. If the number of the known points is relatively small, then the known points are used to centre points of the basis function [5] as in our case as well. In this case the weights of the network can be calculated by solving a set of linear equations:

$$\mathbf{U}\mathbf{a} = \mathbf{d} \quad (4)$$

where $\mathbf{U}$ is the so called interpolation matrix, and its elements are defined as

$$\mathbf{U}_{ij} = \varphi(\mathbf{u}_i - \mathbf{u}_j) \quad (5)$$

and $\mathbf{d}$ is the desired response (i.e. the known function values). If $\mathbf{U}$ is almost singular, the $\mathbf{U}\mathbf{a} = \mathbf{d}$ equation can be solved using the regularization theory.

The benefits of RBF implementation are the following properties:

- Universal approximation in the L_2 space;
- Learning can be carried out analytically (solving a linear set of equations, if the number of neurons in the input layer is the same as the number of neurons);
- The complexity (and hence the approximation capability) of the network can be controlled by the dimensionality of the input vector;

3. NUMERICAL RESULTS

In order to numerically evaluate the outlined concept, one need a test database. However there are many available test databases containing electrical consumption time series, none of them meets our requirements, i.e. appliance-level measurements additionally containing associated environmental parameters. Hence, a multi-channel data acquisition tool were developed, which is able to register the consumption of 8 electrical devices, the outdoor temperature, solar power, and presence of human being in the underlying room. In this paper the first 28 consecutive working days of measurements were investigated. The consumption data for a given appliance (which was the main lighting device of an office) were averaged and normalized for 28 weeks, and for 15 minutes intervals. As a result on-state probabilities were obtained (assuming no seasonality effect during the 28 consecutive days). As input parameters the time of day and outdoor brightness parameters were chosen.

The measurement results can be seen in Figure 3 and 4 Brightness is measured in lux. On the time axis the numbers mean the quarter hours of the day (from 1 to 96).

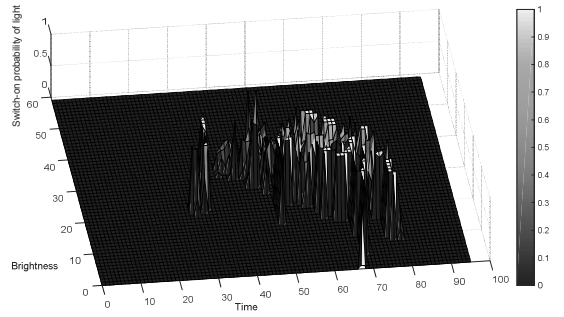

Fig. 3. On-state probability of a lighting device as a function of time and outdoor brightness

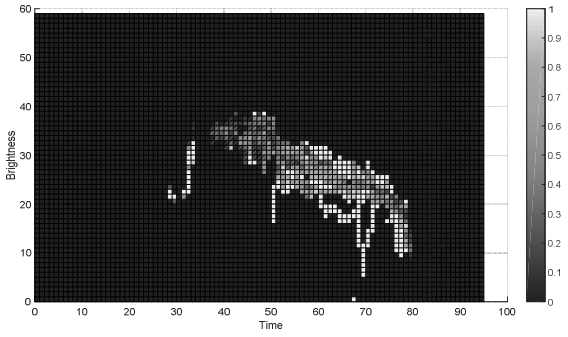

Fig. 4. On-state probability of a lighting device as a function of time and outdoor brightness

The RBF net was trained by equations (4) and (5). The performance was evaluated by cross validation and measured by the Mean Squared Error (MSE) and Mean Absolute Error (MAE).

In each step of the cross validation procedure one of the original function samples was reserved for test, while all the other samples were used to train the net. After training the test element was approximated. The result is depicted by Figure 5 and 6. After going through all the data points by this manner, the MSE resulted to 0.0509, while MAE was 0.1376.

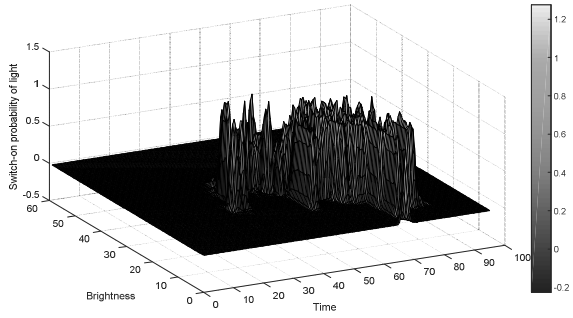

Fig. 5. Approximated on-state probability of a lighting device

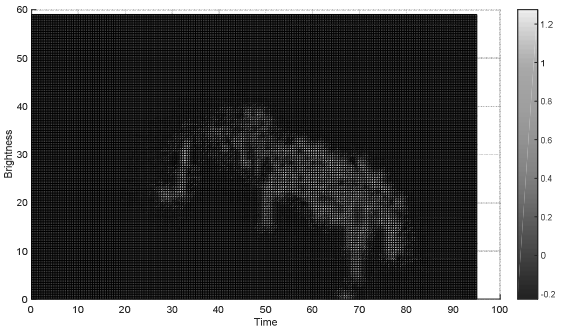

Fig. 6. Approximated on-state probability of a lighting device

In Figure 7 and 8 the absolute difference between the measured values and their approximations are depicted.

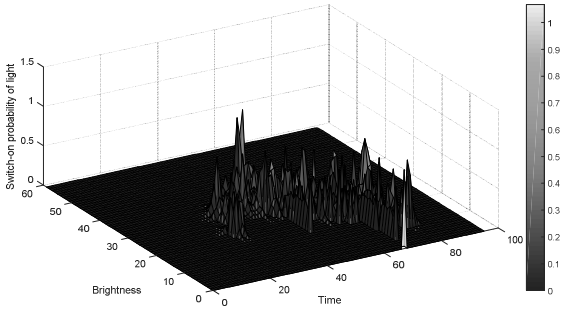

Fig. 7. The absolute difference between measured on-state probability and its approximation

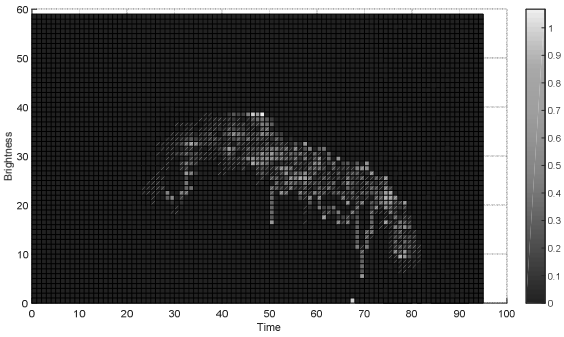

Fig. 8. The absolute difference between measured on-state probability and its approximation

4. CONCLUSION AND FUTURE WORK

In this paper Radial Basis Function Neural Network was used as a function approximator in

order to learn the mapping between time of day and outdoor brightness as inputs and and ON-state probability as output. The tool has been proven to be able to estimate the ON-state probability with a mean absolute error of about 0.1376, which makes the tool suitable for plugging into Consumption Admission Control algorithms to deal with time dependence of statistical descriptors.

In the future work we try to extend the tool for more input parameters and longer time periods in order to enhance the performance of the approximator.

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Preparation of Alumina Foams by the Polyurethane Sponge Replica Method

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Abstract

In this study, highly porous alumina ceramics with an open, three-dimensional network structure were prepared by a simple and low-cost replica method. This method involves the impregnation of a polymeric sponge (typically polyurethane) with a ceramic suspension followed by a heat treatment to burn out the polymeric template. Two different types of commercial polyurethane sponge with pore density of 18 ppi (pores per inch) and 30 ppi were used as the templates. These templates were repeatedly immersed in stable aqueous alumina suspension containing 60 wt. % solid with different additives to obtain uniform and sufficiently thick coating on the sponge struts and to prevent collapse of the ceramic structure during a two-stage sintering at 1600 °C. Factors that predominately affect the uniformity of the coating are the impregnating suspension rheological properties and its adhesion at the polymeric sponge. Therefore, the rheology of aqueous alumina suspension was analysed prior to impregnation. The resulting alumina foams were characterised on properties such as density, porosity, morphological features and compressive strength. It was found that total porosity of alumina foams decreased with increasing pore density of the polyurethane templates which consequently led to the increase of the compressive strength of ceramic foams. The results show that prepared stable ceramic suspension on behalf of above mentioned simple fabrication procedure are suitable for producing highly porous alumina foams.

Keywords: alumina foam, porous alumina, replica method, ceramic suspension

1. INTRODUCTION

Highly porous ceramic materials, i.e. ceramic foams, are lightweight materials with open or closed cellular structure and porosity greater than 60 % [1, 2]. Due to their unique properties such as low density, high chemical and temperature resistance, pore interconnectivity and permeability, ceramic foams have found a wide range of applications, e.g. catalyst supports, filters, thermal insulators, biomedical implants and lightweight structural components [3-5]. Open-cell ceramic foams, so called reticulated ceramics, consist of irregularly shaped prismatic or polyhedral cells interconnected with solid edges (struts) [2, 6].

Nowadays, several processing routes as replica technique, sacrificial template and direct foaming are available for the production of ceramic foams [7]. Polyurethane (PU) replica method is among the most used methods in the ceramic foam manufacturing industry [2, 8]. By utilizing this simple and low cost method it is possible to obtain well-defined open-cell ceramic structure with controllable pore size and geometry just by choosing different PU template [7-9]. Generally, the replica method consists of impregnation of the PU sponge with a ceramic suspension containing an appropriate amount of ceramic particles and additives, followed by a drying of green body and finally sintering. During the high temperature sintering the PU

template is burn out leaving the final ceramic foam which is a replica of the original PU sponge [1, 4, 10]. The major drawback of this method is the mechanical weakness of the produced foams (e.g. strength values ranking from 0.01 to 3 MPa) associated to the formation of an internal void after burn out of the PU sponge and the occurrence of cracks during processing [10-12]. Several approaches as reinforcing foams with the ceramic fibers, repeated impregnation and drying steps and recoating of sintered foam by a low viscous suspension have been suggested to address this problem [13]. A uniform coating on the PU template is recognized as being a critical factor for achieving mechanical reliability. In this process, factor that predominately affects the coating uniformity is a viscosity of ceramic suspension. Generally, suspensions are required to present shear-thinning behaviour to be suitable for a template coating, typically in a dip coating process [12]. Therefore, it is crucial to optimize ceramic suspension by mixing appropriate amount of ceramic particles and additives as dispersants, binders and defoaming agents prior to impregnation [14, 15].

In the present study, two types of highly porous alumina foams are prepared by impregnation of the two types of PU sponge with a high concentrated alumina suspension. The relationship between morphological characteristics and compressive strength of obtained alumina foams are discussed.

2. METHODS AND MATERIALS USED FOR RESEARCH

In order to prepare alumina foams, α-Al_2O_3 powder with 99.78 % purity, mean particle size of 0.5 μm and specific surface area of 6.78 m^2/g (CT 3000 SG, Almatis GmbH, Germany) was used as a starting ceramic material. The commercial reticulated PU sponges with pore density of 18 ppi and 30 ppi (Rekord-tim d.o.o., Croatia) were utilized as the synthetic templates in the replica method.

2.1. Suspension preparation

Aqueous alumina suspension with 60 wt.% solid loading was prepared by dispersing ceramic powders and dissolving additives in distilled water. In order to stabilize the suspension and to improve its adhesion on the template, as well as to achieve uniform coating, organic additives were used in following amount (based on the applied dry ceramic powder):

- 1 wt. % of Dolapix CE 64 (Zschimmer & Schwarz Chemie GmbH, Germany) was used as dispersant to prepare a well-dispersed suspension,
- 3 wt. % poly(vinyl alcohol) 99+% hydrolyzed (PVA; Sigma-Aldrich, SAD) was used as binder to increase suspension viscosity and green body strength,
- 0.5 wt. % of Foamaster MO 2111 (Basf, Germany) was used as defoaming agent to prevent foaming during the replica process.

Initially, PVA was dissolved in distilled water at 60 °C under magnetic stirring at 500 rpm for 1 hour. Afterwards, Dolapix CE 64 and Foamaster MO 2111 were added to the solution and the mixture was further stirred for 15 minutes at room temperature. Finally, alumina powder was added into solution and homogenised in a grinding jar of the planetary ball mill (PM 100, Retsch GmbH, Germany) with ten alumina balls at a speed of 300 rpm for 90 minutes.

2.2. Replica method

The PU sponges were cut into rectangular shapes of 17×17×17 mm and immersed into previously described alumina suspension. Subsequently, sponges were compressed to remove the air and to allow the suspension to fully impregnate the template. The excess suspension was removed by centrifuging process in which centrifugal forces are equally distributed through body providing a uniform coating layer on the surfaces of the PU sponges [4]. After each impregnation - centrifugation step, drying was conducted at 80 °C for 1h. Four

impregnation, centrifugation and drying steps were conducted to reach acceptable coverage of the PU template. After the last step, samples were dried at room temperature for 24 hours and finally subjected to a two-stage sintering process, schematically shown in Figure 1.

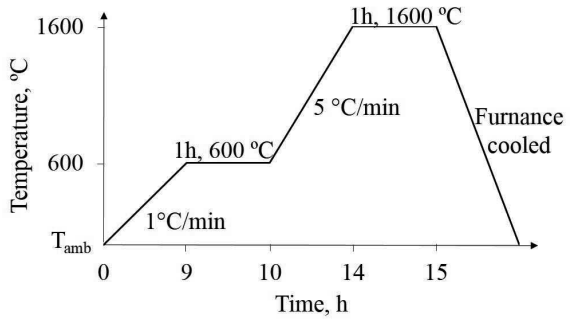

Fig. 1. Schematic diagram of the sintering process

Firstly, pyrolysis of the PU sponge and the organic additives occurred in the temperature range between 250 and 600 °C [16]. To prevent structure from collapsing during burn out of organic matter, slow heating rate of 1 °C/min to 800 °C with 1 hour holding time at 800 °C was applied. Finally, the samples were heated to the sintering temperature of 1600 °C at the rate of 5 °C/min and sintered in air for 1h. The photograph of the sintered alumina foams is shown in Figure 2.

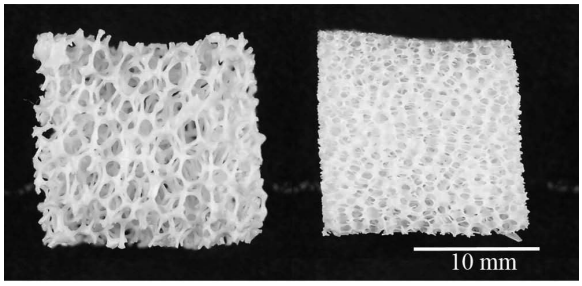

Fig. 2. Photograph of sintered alumina foams obtained by impregnation of PU sponge with pore density of: left – 18 ppi, right – 30 ppi

2.3. Characterization methods

Rheological behaviour of the alumina suspension was determined using a rotational viscometer DV-III Ultra (Brookfield Engineering Laboratories, Inc., USA) in conjunction with Brookfield software, Rheocalc V3.3. The viscosity was measured in a small sample chamber with a spindle SC4-34 at constant temperature of 25±1 °C. Pre-shearing was performed at a shear rate of 30 s^{-1} for 2 min. The shear rate was gradually increased from 0.1 to 70 s^{-1} and then reduced back to 0.1 s^{-1} with 100 equal intervals. After each interval measured values were automatically recorded. To evaluate obtained results, Herschel-Bulkley model (Eq. 1) was used since it is among the most appropriate models for describing ceramic suspensions, e.g. non-Newtonian fluids [14]. Above mentioned model can be expressed as (Equation 1):

$$\tau = \tau^{\circ} + kD^{n} \quad (1)$$

where τ is the shear stress, τ^{o} is the yield stress, k is the consistency index, D is the shear rate and n is the flow index which describes fluid behaviour ($n < 1$ shear thinning behaviour, $n = 1$ Newtonian behaviour, $n > 1$ shear thickening behaviour).

The morphological features of alumina foams were characterised with a scanning electron microscope (Tescan Vega 3, Tescan, Czech Republic) and an optical microscope (Olympus BX51, Japan). In order to determine the average pore size (face diameter) and the average strut diameter, image analysis was processed using software Motic Images Plus 3.0. Due to the fact that the foams are not absolutely isotropic and the cells are elongated, the face diameter depends on the orientation of the sample [17]. Hence, the shortest and the longest face diameter being orthogonal to each other were measured and presented as arithmetic mean of at least twenty measurements.

Total porosities (ϕ) of sintered alumina foams were calculated using the following equation (Equation 2):

$$\phi = 1 - \frac{\rho}{\rho^{*}} \quad (2)$$

where ρ is the bulk density of alumina foam calculated from the mass to bulk volume ratio and ρ^{*} is the theoretical density of Al_2O_3 (3.986 g/cm^3). Total porosity mean value was calculated from eight porosity measurements for each type of alumina foam.

The compressive strength (σ) of sintered samples with dimension of approximately 15×15×15 mm was measured using universal testing machine (WPM VEB Thüringer Industriewerk, Germany) with a cross head speed of 5 mm/min. The compressive strength was determined from the maximum load at failure and the loaded surface area. Eight samples were tested to obtain an average value.

3. RESULTS AND ACHIEVEMENTS

3.1. Rheological properties

Rheological flow curves for the prepared alumina suspension are shown in Figure 3. They are expressed as a dependence of viscosity (A) and shear stress (B) on the applied shear rates. As can be seen in Figure 3, with increasing shear rate the viscosity decreases (A) and the shear stress increases (B), indicating the shear-thinning (or pseudoplastic) behaviour of the prepared suspension, necessary for a replica process.

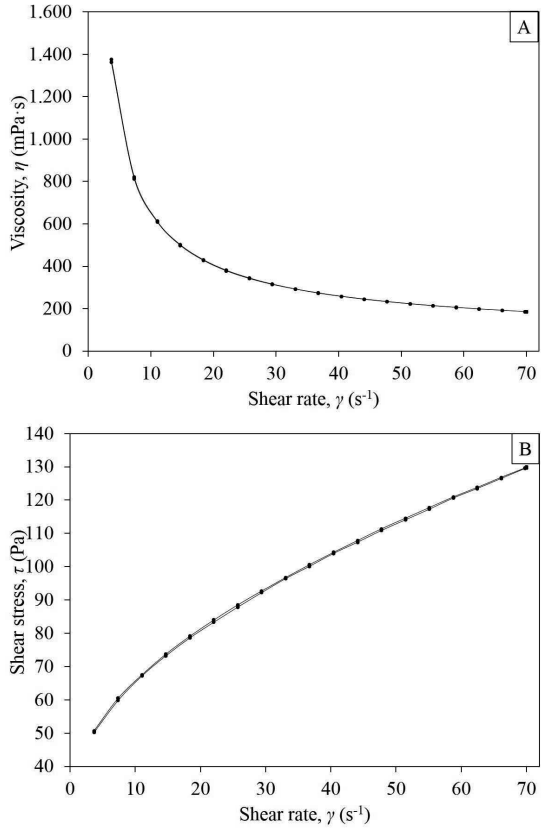

Fig. 3. Flow curves for alumina suspension

The low suspension viscosity during immersion, when a high shear rate is applied by compression and expansion of PU template, allows suspension to enter, fill and uniformly coat the template. Conversely, increasing in viscosity at the end of the impregnation process when a shear rate is low, enables the suspension to remain on the template surface. Therefore, the optimisation of the suspension composition to achieve the pseudo-plastic behaviour seems to be crucial for the production of ceramic foams with desired properties.

The rheological parameters obtained by fitting the experimental data to the Herschel-Bulkley model as well as the viscosity at the shear rate of 70 s^{-1} are presented in Table 1.

Table 1. Rheological parameters

η, mPa·s	k, mPa·s	n	$\tau°$, N/m^2	R^2
185.45	962.6	0.55	3.13	1

The R^2 value of 1 indicates that the applied model perfectly fits the experimental data. Considering that $n < 1$, shear-thinning behaviour of the alumina suspension was confirmed.

3.2. Morphological characteristics and compressive strength

It is well known that the compressive strength of macroporous brittle solids depends on the porosity, pore size, pore interconnectivity and thickness of the struts [18]. Hence, the selected morphological features and the obtained compressive strengths are considered together and summarized in Table 2. It can be seen from the data in Table 2. that the compressive strength of alumina foams increases with an increase in foam density and decrease in a foam porosity, strut diameter and pore size.

Except previously mentioned, the number of defects in the foam structure as a consequence of the coat quality (e.g. suspension properties), the processing route and the heat treatment also significantly affect the final properties of ceramic foams. Figure 4 shows the SEM images of 18 ppi foam (A1-3) and 30 ppi foam (B1-3). As can be seen form the Figure 4, an open-cell structure (originates form PU template) with

some characteristic defects was obtained for both, 18 ppi foam and 30 ppi foam. More strut defects (i.e. cracks along the foam struts) were found for 18 ppi alumina foam (Figure 4. A2) compared to 30 ppi alumina foam, which support lower compressive strength of 18 ppi foam. The above mentioned cracks were probably induced due to the mismatch in thermal expansion coefficient between polymeric PU template and inorganic ceramic material, despite the low heating rate during sintering.

As can be seen in Figure 4., the struts of the produced foams are hollow. These triangular voids inside alumina struts are typical in replica method, given that they occur during the PU template burnout. Due to an angled shape of voids and a high stress concentration in the ceramic foams, the longitudinal strut cracks can be easily generated (Figure 4. A3) resulting in the low mechanical strength.

The compressive strengths of 0.20 MPa and 1.40 MPa for 18 ppi and 30 ppi alumina foams were obtained, respectively. Considering that there has been no standard testing method, it is difficult to compare results of compressive strengths with those of other studies. However, it has been found that the obtained results are consistent with previous findings in the literature [4, 14].

Table 2. Properties of produced alumina foams

Foam	ppi	ρ, g/cm^3	ϕ, %	Strut diameter, µm	Pore size, µm	σ, MPa
Al_2O_3	18	0.23	94.3	339.09	1997.27	0.20
	30	0.51	87.1	119.17	765.42	1.40

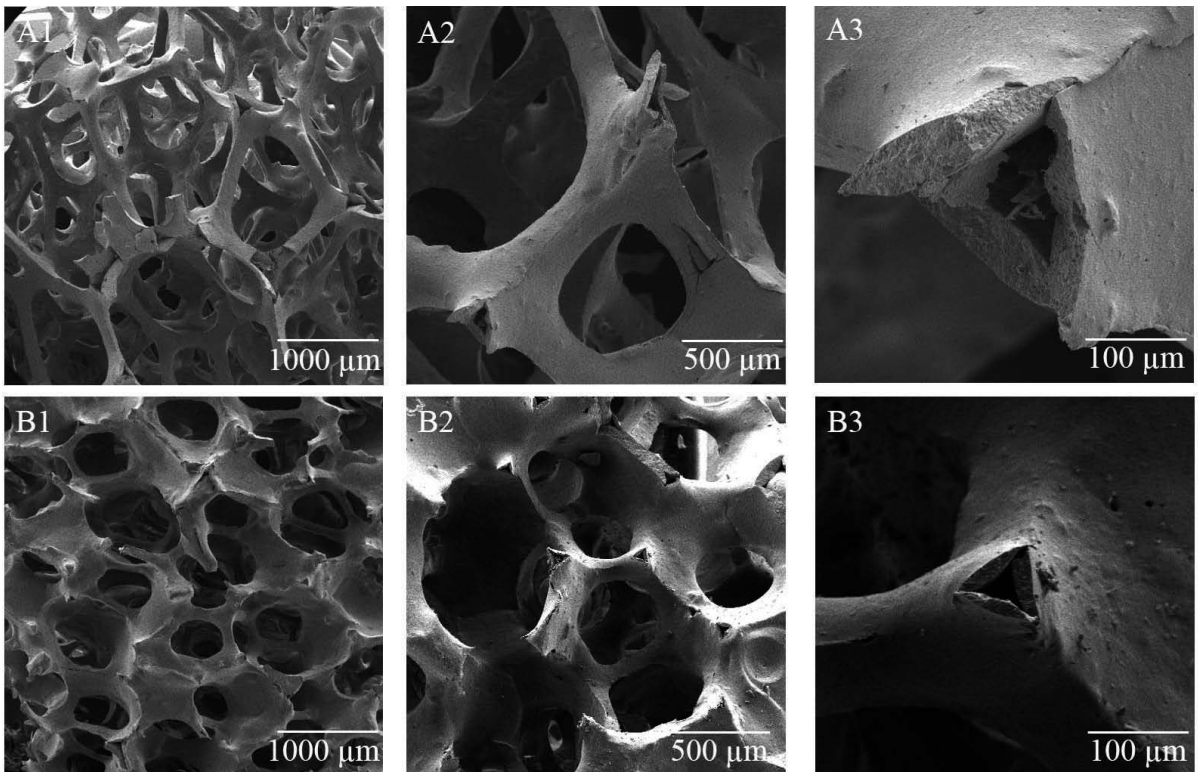

Fig. 4. SEM images of the alumina foams produced from 18 ppi PU template (A1-3) and 30 ppi PU template (B1-3)

4. CONCLUSIONS

In this study, two open-cell alumina foams with different porosities were successfully prepared by an easy and low-cost replica method. Stable 60 wt. % aqueous alumina suspension was prepared for impregnation the 18 ppi and 30 ppi PU sponges. Stability of prepared suspension was achieved by addition of different additives (Dolapix CE 64, PVA and

Foamaster MO 2111). After four time repeated impregnation processes, the green bodies were sintered by applying slow heating rates of 1 °C/min to 800 °C and 5 °C/min to 1600 °C, to prevent collapse of the structure due to mismatch in the thermal expansion coefficient between PU sponge and alumina ceramics.

The porosity of produced alumina foams (94.3 and 87.1 %), the average pore size (1997.27 and 765.42 μm) and the average strut diameter (339.09 and 119.17 μm) decreased with the increase in PU template pore density (18 and 30 ppi). The morphological observation indicates that morphological features of alumina foams together with defects in foam struts have a significant effect on the compressive strength of open-cell alumina foams. Therefore, the main advantage of employing the replica method in production of ceramic foams is the fact that the important morphological features can be easily controlled by selecting appropriate PU template and, more importantly, by optimising suspension rheological features.

5. ACKNOWLEDGEMENTS

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Nanoindentation Study of Ultrafine-Grained Titanium-Based Materials

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Abstract

The commercially pure titanium (cpTi) and especially titanium (Ti) alloys are materials increasingly used in orthopaedic and dental implants. In order to enhance the implant material properties, Ti-based materials may be modified by severe plastic deformation (SPD) methods. One of the most attractive SPD methods is high-pressure torsion (HPT), as a method for obtaining submicron-sized grains, with the aim to improve, among others, mechanical properties of metallic materials. In the present study, ultrafine-grained titanium (UFG cpTi) and ultrafine-grained Ti-13Nb-13Zr (UFG TNZ) alloy samples were obtained by high pressure torsion (HPT) under a pressure of 4.1 GPa with a rotational speed of 0.2 rpm up to 5 rotations at room temperature. The homogeneity of the material was determined by using Vickers microhardness tester and analysing the obtained microhardness profile along the samples diameters. The results show that materials are reasonably homogeneous after HPT processing. The aim of this study is to determine the mechanical behaviour of the commercially pure titanium and titanium alloy before and after HPT processing using the nanoindentation technique. Obtained results show that ultrafine-grained materials have lower modulus of elasticity than coarse-grained (CG) materials, which means that the values are closer to those of bones, making the discontinuity of mechanical properties at the bone-implant interface less pronounced. On the other hand, UFG materials have higher values of nanohardness than CG materials.

Keywords: biomaterials, high pressure torsion, modulus of elasticity, nanoindentation, titanium alloys

1. INTRODUCTION TO BIOMATERIALS

The commercially pure titanium (cpTi) and especially titanium (Ti) alloys are materials increasingly used in orthopaedic and dental implants [1]. The first generation of titanium alloys has had good clinical results, but the modulus of elasticity of this alloy (110 GPa) is much higher than that of human bone (10-30GPa) [2]. The newly developed α+β - type and β - type titanium alloys have better characteristics such as higher corrosion resistance and lower modulus of elasticity, which is closer to that of a bone [2-4]. One of these alloys is Ti-13Nb-13Zr. In order to enhance the implant material properties, commercially pure titanium and titanium alloy may be modified by different techniques, among others by severe plastic deformation (SPD) methods [5]. One of the most attractive SPD methods is high-pressure torsion (HPT) [6, 7], which is a method for obtaining submicron-sized grains, with the aim to improve, among others, mechanical properties of metallic materials, Fig. 1. The possible inhomogeneity of

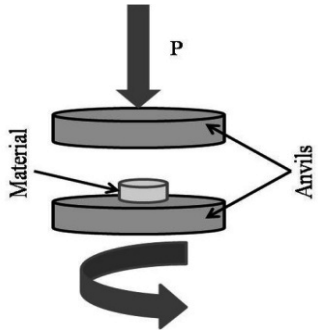

Fig. 1. Schematic of the HPT process

metallic materials after HPT process is a very important issue that should be checked. In this study, inhomogeneity of materials was determined by using Vickers microhardness tester and analysing the obtained microhardness profiles along the samples diameters.

Behaviour of the metallic biomaterials is also regulated by surface properties, which is a crucial factor in interactions of the implant material with the surrounding tissue. Because of that, in this study nanoindentation technique was used in order to determine the modulus of elasticity and nanohardness of the commercially pure titanium after HPT processing and titanium alloy before and after HPT processing.

2. MATERIALS AND METHODS

The commercially pure titanium (cpTi) and Ti-13Nb-13Zr alloy (TNZ) in the initial state were disk-shaped samples with a diameter of 28 mm and thickness about 2.2 mm. The samples were subjected to HPT process in order to obtain ultrafine-grained cpTi (UFG cpTi) and ultrafine-grained Ti-13Nb-13Zr (UFG TNZ) alloy. HPT was performed at room temperature with a device, which has two anvils with circular flat-bottom depressions at the centre. Each disc was placed between the anvils, a pressure of 4.1 GPa was applied and the disc was torsionally strained through rotation of the lower anvil. Strains were imposed on the discs by processing at a constant speed of 0.2 rpm through 5 revolutions. The obtained samples of UFG cpTi and UFG TNZ alloy were disc-shaped with a diameter of 34 mm and thickness approximately 0.7 mm.

2.1. Microhardness measurements

The Vickers microhardness (HV) was measured on the surfaces of the discs samples using TIME HVS-1000 microhardness tester machine under a load of 4.903 N and a dwell time of 5 s with a distance of 1 mm between each indentation. The measurements were performed along the diameters on each sample. The value of HV for each indentation was estimated from the average of four hardness measurements. Before measurements, samples were wet-ground with 150 µm to 4000 µm grit silicon carbide paper and polished.

2.2. Mechanical characterization

The nanoindentation test was performed on the surfaces of the disc samples using Nanoindenter G200, Agilent Technologies. The test was controlled using total displacement of 2000 nm. Ten measurements were made on each sample and the mean values were calculated. All tests were applied to assess the surface mechanical properties of materials after HPT processing.

3. RESULTS

The HV of UFG Ti-13Nb-13Zr alloy and UFG cpTi as a function of the diameter of the disk - shaped samples before and after HPT processing are presented in Fig. 2.

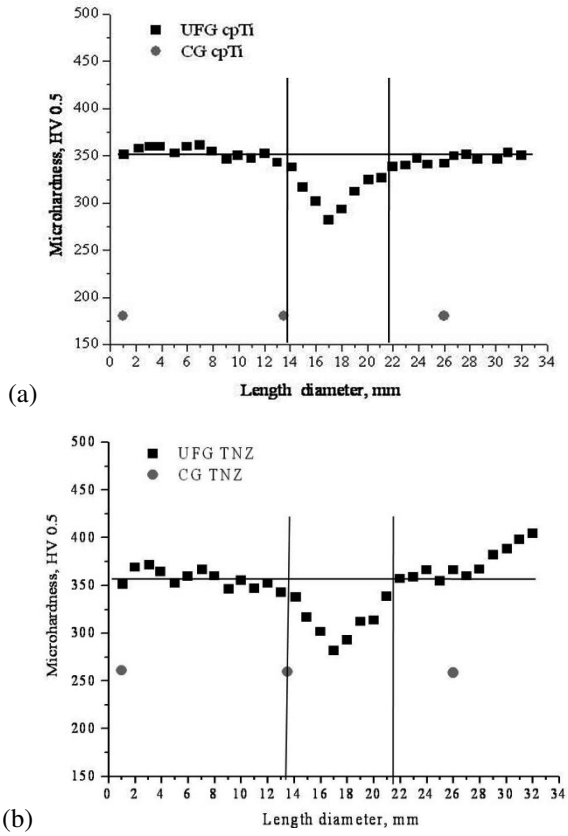

Fig. 2 Vickers microhardness of UFG cpTi (a) and UFG Ti-13Nb-13Zr alloy (b) as a function of the sample diameter

As can be seen in Fig. 2a, the microhardness value of cpTi significantly increases after HPT

processing, from 180 HV in the initial state to an average of 350 HV. Also, the microhardness of the Ti-13Nb-13Zr alloy was significantly enhanced by HPT processing such that the average hardness increased from 259.73 HV for the coarse-grained (CG) sample to 350.34 HV, Fig. 2b. Two important conclusions can be drawn from Fig.2. First, the microhardness of cpTi and Ti-13Nb-13Zr samples increases significantly through HPT processing by comparison with the CG one. Second, the HPT-processed cpTi and Ti-13Nb-13Zr samples processed through 5 turns have lower microhardness values in the centre (between two horizontal line in Fig. 2), in comparison with the other parts of the samples. For the UFG Ti-13Nb-13Zr alloy microhardness values are changed from 301.7 HV in the centre to 342.9 HV to the edges, while for the narrow region around the one edge, microhardness value is about 400 HV (this part of sample is cut and is not used in experiments). For the UFG cpTi microhardness values are changed from 300 HV to 350 HV.

Increase of the value of microhardness from the centre toward the edges of the sample is related to the fact that the value of torque is zero in the centre increasing in the radial direction and reaches its maximum at the edges of the samples during the process of HPT. Also, due to the variation in shear strain, γ, across each disc during HPT processing, value of γ at different positions of the disc is estimated by [8]:

$$\gamma = \frac{2\pi NR}{h} \qquad (1)$$

where N is the number of revolutions, R is the radial distance from the centre of the disc and h is the disc thickness.

For the specimen processed through 5 turns, the obtained microhardness values, outside the narrow region near the disc centre (between two vertical lines) and outside the narrow region around the one edge of disc (from 31 mm to 34 mm in diameter length), are narrowly distributed from point to point variation (along the horizontal line) of $\pm$ 16 HV, see Fig. 2b. So, it could be said that the reasonably uniform microstructure is achieved after 5 turns of HPT processing, with the exception of a narrow area around the centre of the sample with diameter of about 4 mm and a narrow area around one edge of the disc from 31 mm to 34 mm in diameter length (these parts of the sample are not used in experiments).

The microstructure characterisation of ultra-fine grained titanium and titanium alloys is very difficult to do using usual microscopes, like optical microscope or scanning electron microscope. The microstructure characterisation of ultra-fine grained metallic materials is usually done on a transmission electron microscope, and the available literature shows the homogeneous microstructure after the HPT process [9, 10].

The microhardness value of Ti-13Nb-13Zr, in the initial state, has no large deviations, which indicates a homogenous microstructure. In point of fact, decreasing of the grain size with HPT processing in UFG Ti-13Nb-13Zr alloy leads to a significant increase in the microhardness, while the microstructure remains homogeneous (except in the narrow zone around the centre of the sample and the narrow zone around the one edge of the sample). The results are in agreement with I. Dimić et al. [10], who showed that the average microhardness value of Ti-13Nb-13Zr alloy increases from 230 HV in the initial state to 300 HV, 355 HV and 360 HV after HPT deformation up to 7.8 GPa and ¼, 1 and 5 rotations, respectively. They concluded that microhardness increases with the increase of the number of rotations in the case of this Ti-based alloy. The results in this study confirm the potential of using HPT processing to achieve reasonably homogeneous microstructures.

After the analysis of materials homogeneity, examination of mechanical surface properties was done using nanoindentation (as mentioned previously, the region in the centre of UGF processed samples is excluded from the tests). The displacement during nanoindentation was 2000 nm for each sample, and maximum mean values of load on the sample were approximately 200 mN, 250 mN and 375mN for CG TNZ, UFG TNZ and UFG cpTi,

respectively. Fig. 3 represents loading-displacement curves obtained during the nanoindentation tests. Each curve consists of the loading part, the dwell period at the maximum load of the indentation and the unloading part. The diagram shows the change in depth with the dwell period at the maximum load.

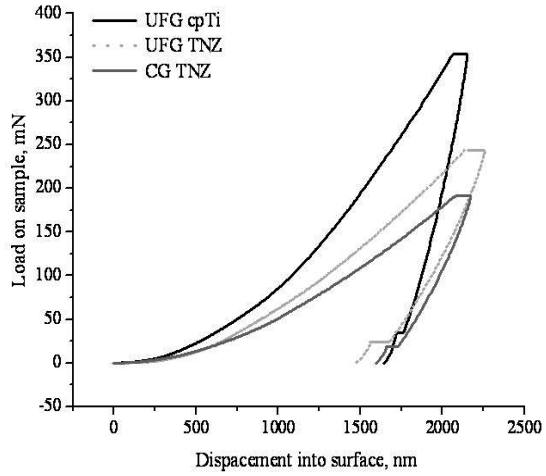

Fig. 3. Loading-displacement curves for examined materials

The difference between the loading part and the unloading part on the diagram indicates the presence of the permanent (plastic) deformation. The mean values of surface mechanical characteristics, nanohardness and modulus of elasticity, obtained from nanoindentation test, are presented in Table 1 and Fig. 4 and 5.

Table 1. Mean values of mechanical properties

Materials	UFG cpTi	CG TNZ	UFG TNZ
Modulus of elasticity, GPa	104.56	61.301	59.987
Nanohardness, GPa	3.54	2.393	2.691
Nanohardness, HV	361	244	274

The results show that the modulus of elasticity is lower after HPT process, Fig. 4. UFG TNZ alloy has the lowest modulus of elasticity, which indicates that it is the most acceptable material for the metallic implant. The lower value of modulus of elasticity and closer to that of a bone is one of the crucial factors in accepting the implant material from the surrounding tissue, and reduces the possibility of slow disappearance of bone in contact with the implant - "shielding effect" [11]. The commercially pure titanium typically has a modulus of elasticity of 120 GPa after the nanoindentation test [12]. This indicates that UFG cpTi has lower modulus of elasticity than the pure titanium.

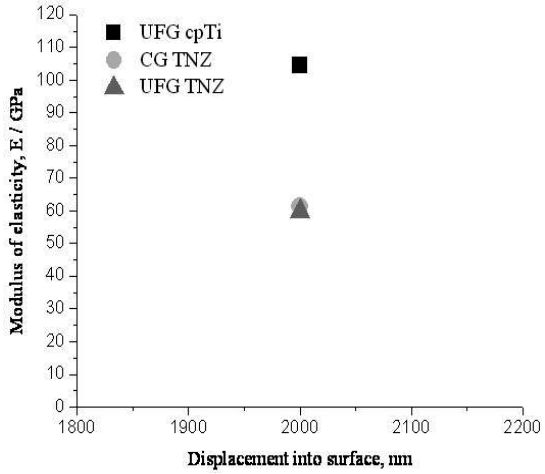

Fig. 4. Modulus of elasticity obtained using nanoindentation for examined materials

On the other hand, the nanohardness values of ultrafine-grained materials are higher than those obtained for coarse-grained materials, Fig. 5.

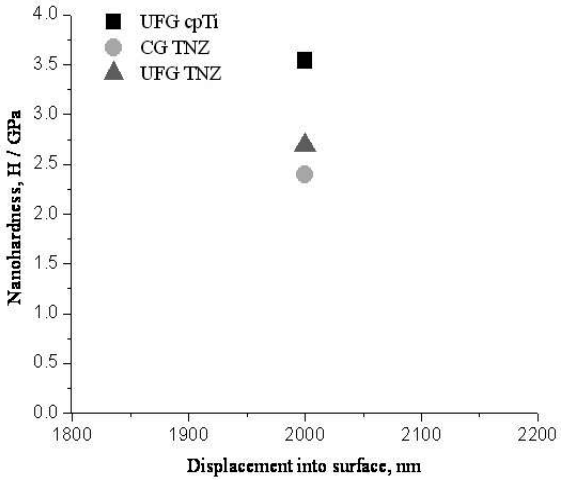

Fig. 5. Nanohardness values obtained using nanoindentation for examined materials

4. CONCLUSIONS

The results show that high pressure torsion is an acceptable process for metallic biomaterials. The materials after HPT process show adequate homogeneous microstructure. The values of microhardness are higher after HPT process. The nanoindentation tests show that UFG materials have lower modulus of elasticity,

which make them more acceptable as metallic biomaterials than CG materials. Future examination will include the formation of a nanotubular oxide layer on the surface of the above mentioned materials and the examination of surface mechanical properties using the nanoindentation test.

5. ACKNOWLEDGEMENTS

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Safety Mechanism for Stubble Cultivators: Kinematic and Dynamic Analysis

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Abstract

Adequate soil cultivation is essential for the growth and high yield of crops. Modern agricultural machinery, such as stubble cultivator, reduces the number of passes resulting less processing costs. Stubble cultivators work in extreme conditions wherefore working links are often overloaded. Therefore, special attention has been devoted to the structure of a stubble cultivator. The paper presents the kinematic and dynamic analysis of the spring mechanism for overload protection on cultivators. It consists of a 4-bar lever mechanism with an elastic element which allows the moving if the working link in case of overload. Based on the set requirements, the kinematic analysis was done and the characteristic positions of the working link were determined. By the dynamic analysis, kinetostatic equations were formed and based on it, the value of forces which are acting on working link were determined during the motion of it. By comparing the obtained value with the desired values, it is concluded that there is a certain deviation of the working force.

Keywords: agriculture, stubble cultivators, safety mechanism, kinematic analysis, dynamic analysis

1. INTRODUCTION

The main goal of the soil cultivation is the forming of proper conditions for intensive growth of plants. Adequate soil cultivation is crucial for high yields of crops. There are three basic systems for soil cultivation – conventional treatment, reduced treatment and direct sowing (no-till). Conventional treatment involves the cultivation of soil with overturning – plowing. However, its application is accompanied by high costs. Even 50–55% of the total cost of land processing refers to plowing, or 38–42% of the total cost in the production of o crop [1]. Processing costs can be reduced by reducing the number of passes and the depth of the soli cultivations. In relation to conventional treatment, reduced soil treatment systems involve a modern soil cultivation process. Modern agricultural machinery enables less passes which results in less processing costs. Reduced soil treatment systems provide 52% less soil cultivation costs than conventional plowing systems [2]. Direct sowing is a soil treatment system where sowing of crops is carried out in one pass using modern agricultural mechanization. By direct sowing, only parts of the soil around the plants is treated, so-called soil preparing in rows. After some years of application of the reduced or no-till soil treatment, it is necessary to apply plowing to avoid the effect of yield reducing [3].

The paper presents a kinematic and dynamic analysis of the safety mechanism for stubble cultivators, in case of the Horsch – Terrano cultivator.

2. STUBBLE CULTIVATORS

Stubble cultivators are agricultural machines used for different types of reduced soil treatment

systems, instead of plows – Figure 1. Used for shallow cultivation of plant residues immediately after harvesting, for medium and deep cultivation and intensive mixing of plant residues, for deep cultivation on compacted lands, for seedbed preparation in the spring, as well as for mixing solid and liquid manure with soil. Working depth are in range from 5 to 25 cm. Because of this, stubble cultivators are efficiently applied for basic cultivation instead of plows.

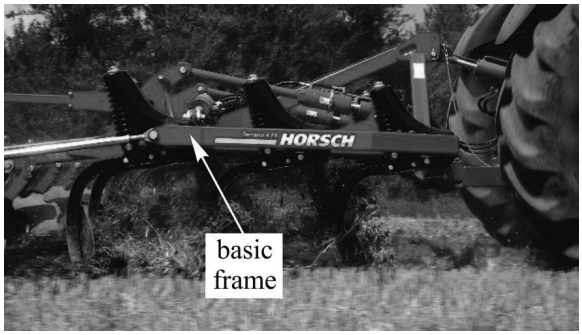

Fig. 1. Stubble cultivator in operation

The land, which is treated with stubble cultivator keeps, more moisture in the lower and upper layers of the soil than the soil treated with a plow. In addition, the use of cultivator prevents the formation of compressed soil layer, which is located just below the cultivated layer. Also, the use of the stubble cultivator, increases the capillarity of the soil, which is a significant advantage.

An analysis of the pulling force of the tractor for the soil cultivation with stubble cultivators, depending on the type of the soil and the working speed is shown in [4]. Measurements were made for two types of soil – sandy soil and loam soil, depending on the depth of cultivation. The tests showed the change in the pulling force in relation to the depth of cultivation, but the dependence of the working speed and the pulling force has not been proven. Therefore, the pre-testing in the working conditions is recommended, before the selection of stubble cultivator. An adequate selection of cultivator provides significant saving, especially in fuel consumption.

Stubble cultivators operate in very difficult working conditions. It is a common case that there are rocks in the soil, which cause a great impact on the working link of the cultivator. Because of the difficult and changing working conditions, it is necessary to limit the intensity of the working force that affects the working link. The limitation of the force is carried out using a safety bolt or a mechanism with an elastic elements – spring. Manufacturers such as Lemken [5], [6], Kuhn [7], Vaderstad [8] and Horsch [9] produce stubble cultivators with both of the overload protection systems of a working link. Which system will be applied depends on the type of soil and working conditions that significantly affects the cost of the machine.

Overload protection system of cultivator using a safety bolts, principally consists of a working link attached to the basic frame – Figure 1, by two bolts. One of them is a safety element for overload protection, the other represents joint around which the working link rotates in case of overload. This is the simplest and the cheapest solution. However, each time the overload occurs, a safety bolt must be replaced. During this time the machine is not in operation.

All the aforementioned manufacturers of stubble cultivators, use an overload protection system using an elastic element in almost the same way. During the cultivation of soil, when a working link encounters an obstacle in the soil, then the load – the force that affects the working link, increases. When the force reaches the critical value, the spring activates – compresses. As a result, the working link moves upwards and thus avoids the obstacle in the soil. After the reduction of working force intensity, the force in the spring overcomes the resistance of the soil and thus returns the working link to the initial – working position. The advantage of this mechanism compared with the safety bolt to automatically restore the working link into its initial position. However, due to the significantly higher price, the application of this type of overload protection is justified on lands which are difficult to cultivate, and the mechanism often activates.

Figure 2 shows the safety mechanism – overload protection of the working link of stubble cultivators with helical compression spring. The safety mechanism consists of a mechanism support (1), guide (3), compression spring (4) and working link formed of the support (2a), tine (2b) and the share (2c).

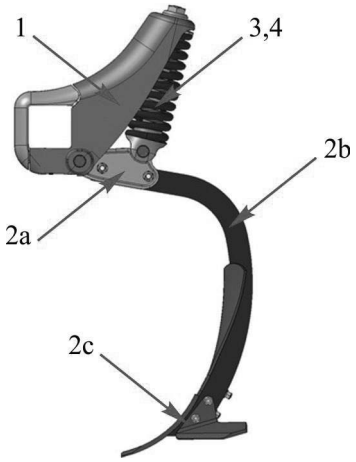

Fig. 2. Safety mechanism with elastic element for stubble cultivators: 1 – mechanism support, 2a – support of working link, 2b – tine, 2c – share, 3 – guide and 4 – compression spring; note: links 2a, 2b and 2c forming the working link

3. KINEMATIC ANALYSIS

The working efficiency and the reliability of a stubble cultivator depends on the working characteristic of the safety mechanism which implies the dependence of the intensity of working force – the resistance force of the soil that affects the working link, and the stroke – height of the lifting of the working link. However, when the stiffness of the spring is low, than the safety mechanism activates at a low intensity of working force, and the working link jumps on the soil, which is undesirable. If the stiffness of the spring is too high then the safety mechanism does not react, and in case of overloading, the damage of the machine can occur. Figure 3 shows the desired working characteristics of the mechanism, adopted on the basis of recommendations of manufacturer Horsch [9].

It is desirable that the reaction force of the mechanism is around 5 kN. By the activation of the working link and its moving upwards the force must not exceed 6 kN. After 1/3 of the stroke, the force must decrease and at the end of the movement has a minimum value. The stroke of the working link should be 300 mm in the vertical direction.

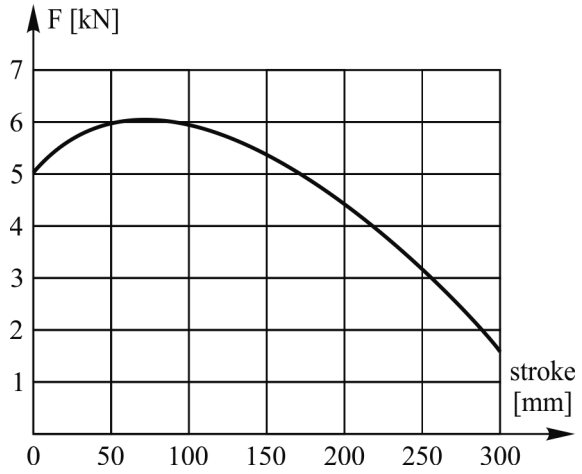

Fig. 3. Desired working characteristics of the mechanism

Based on the adopted dimensions, the model of the mechanism is formed and it is shown in Figure 4. The kinematic analysis was made for six characteristic positions of the working link – the vertical movement of point D is y_D=300 mm.

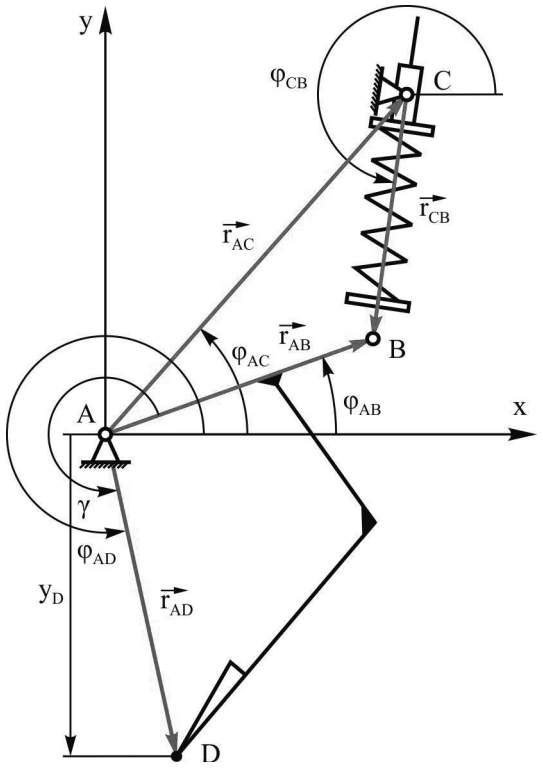

Fig. 4. Kinematic scheme of the cultivator mechanism

Each position corresponds to the movement of the tip of the working link for 60 mm in vertical direction – the first is the zero position.

Taking into account that the working link DAB is purchased as a final product – its shape can not be changed, the value of the parameter r_{AD} is known and does not change during the motion. Angle γ represents the angle between vectors $\overrightarrow{r_{AB}}$ and $\overrightarrow{r_{AD}}$ which also does not change during the motion. Parameter y_D is defined by the geometry of the working link and it is measured from the axis of rotation of the working link – point A, to the point of the acting of working force – point D. Consequently, for known parameters, y_D, r_{AD} and γ are adopted, and based on it, φ_{AD} and φ_{AB} are defined.

$$\varphi_{AD} = arcsin\left(\frac{y_D}{r_{AD}}\right) \tag{1}$$

$$\varphi_{AB} = \varphi_{AD} - \gamma \tag{2}$$

In vector contour:

$$\overrightarrow{r_{AC}} + \overrightarrow{r_{CB}} = \overrightarrow{r_{AB}} \tag{3}$$

known parameters are r_{AC}, r_{AB}, φ_{AC} and φ_{AB}, where is r_{AC} – length of the vector between the axis of rotation of the working link and the upper spring connection point, φ_{AC} – angle of this vector, r_{AB} is the length of vector between the axis of rotation and the lover connection point of the spring, and φ_{AB} – angle of this vector.

The parameters which have to be determined are r_{CB} and φ_{CB}, which represent the length and angle of the vector between the lower and upper connection points of the spring – points B and C, respectively. These parameters define the length and the position of the spring during the motion. By projecting Eq. (3) to axes of the coordinate system *x* and *y*, the following equations are obtained:

$$r_{AC} \cdot cos\varphi_{AC} + r_{CB} \cdot cos\varphi_{CB} = r_{AB} \cdot cos\varphi_{AB} \tag{4}$$

$$r_{AC} \cdot sin\varphi_{AC} + r_{CB} \cdot sin\varphi_{CB} = r_{AB} \cdot sin\varphi_{AB} \tag{5}$$

from which the variables are determined:

$$r_{CB} = \frac{r_{AB} \cdot cos\varphi_{AB} - r_{AC} \cdot cos\varphi_{AC}}{cos\varphi_{CB}} \tag{6}$$

$$\varphi_{CB} = arctan\left(\frac{r_{AB} \cdot sin\varphi_{AB} - r_{AC} \cdot sin\varphi_{AC}}{r_{AB} \cdot cos\varphi_{AB} - r_{AC} \cdot cos\varphi_{AC}}\right) \tag{7}$$

Based on Eqs. (1), (2), (6) and (7), the dimensions of the mechanism are determined in all positions during the motion, as it is shown in Table 1.

Table 1. Results of the kinematic analysis

Position	y_D [mm]	r_{CB} [mm]	φ_{AB} [°]	φ_{AD} [°]	φ_{CB} [°]
0.	–750.41	388.99	–352.74	–71.33	–98.99
1.	–658.56	341.61	–337.65	–56.24	–102.54
2.	–583.11	318.36	–328.81	–47.40	–106.06
3.	–512.78	303.38	–321.75	–40.34	–109.67
4.	–445.41	293.60	–315.63	–34.22	–113.32
5.	–380.09	287.71	–310.09	–28.67	–116.95

4. DYNAMIC ANALYSIS

By dynamic analysis the drive forces of the mechanism are determined. Using the d'Alembert's principle, kinetostatic equations are formed:

$$\sum \vec{F}(i) = 0 \tag{8}$$

$$\sum \vec{M}(S_i, i) = 0 \tag{9}$$

where is S_i – arbitrary point of *i*-th link.

Eqs. (8) and (9) contain workloads on the *i*-th link, the inertial and gravitational forces of the *i*-th link, the friction forces – dry and viscous, and the reactions of the *i*-th link with the other links of the mechanism. Considering the relatively low mass of the links of the mechanism, the inertial, gravitational and frictional forces are negligible in relation to the workload – soil resistance.

Figure 5 shows the model of the mechanism with loads which are acting on it. By decomposition of the mechanism, for each link, kinetostatic equations are formed. Based on that, a system of 9 linear equations with 9 unknown parameters was obtained. Their solution provides the components of the reaction forces in the joints, as well as the necessary driving

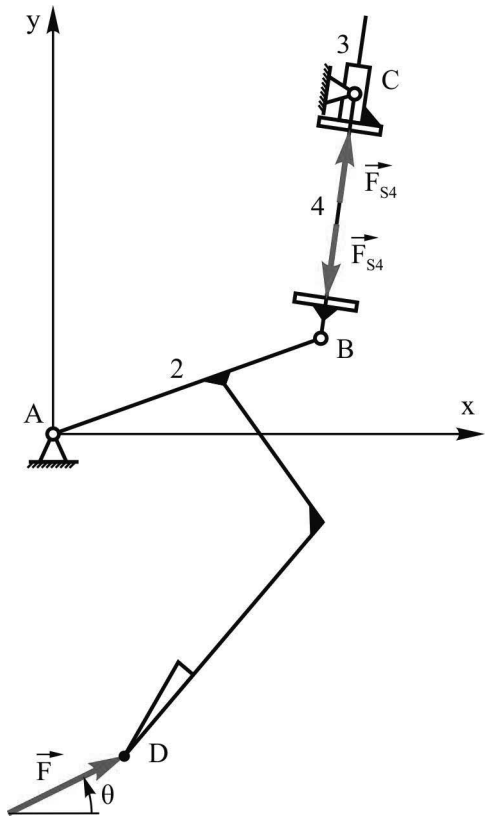

Fig. 5. Scheme of the loads on the mechanism

force: F_{34}, M_{34}, F_{14} ($F_{14}x$, $F_{14}y$), F_{23} ($F_{23}x$, $F_{23}y$), F_{12} ($F_{12}x$, $F_{12}y$) and F.

It should be noted that the start-up of the mechanism takes place under the effect of the soil resistance force F, wherefore this force is considered as a driving force. This force has components:

$$F_x = F \cdot cos\theta \tag{10}$$

$$F_y = F \cdot sin\theta \tag{11}$$

where is θ – angle of direction of force F.

The angle of the direction of force F is very difficult to determine analytically, and neither experimental tests can be reliably determined. In addition, each type of working link behaves differently during the cultivation, which further complicates the determining the direction of the working force. Therefore, it is assumed that the angle θ during the motion of the working link decreases proportionally in each of the six positions, in the range from –30° to 0°.

The force in the spring F_{S4} depends on the force of pre-stressing of the spring, the stiffness of the spring and the reduction of the length r_{BC}, during the motion of the mechanism, so:

$$F_{S4} = F_{S0} + \Delta l \cdot k \tag{12}$$

where is F_{S0} – pre-stressing force of the spring, Δl – a change in length, or a shortening of the spring, that represents the difference of distance r_{CB} at the beginning and at the end of the motion, and k – the stiffness of the spring.

At the beginning of the motion Δl(0)=0, while for the other positions it is determined according to:

$$\Delta l(i) = r_{CB}(i) - r_{CB}(i-1),\ i = 1,2,...,5 \tag{13}$$

Finally, the working force is determined by:

$$F = \frac{r_{AB} \cdot sin(\gamma - 90° - \varphi_{AB})}{r_{AD} \cdot sin(\theta - \varphi_{AD})} \cdot (F_{S0} + \Delta l \cdot k) \tag{14}$$

Table 2 shows the results of dynamic analysis for the characteristic positions during the whole motion, where in the initial position, the pre-stressing force is F_{S0}=10 kN, and the adopted stiffness of spring is k=100 N/mm.

Table 2. Results of dynamic analysis

Δl [mm]	F_{S4} [kN]	θ [°]	F [kN]
0	10	–30	3.67
47.38	14.74	–24	5.72
70.64	17.06	–18	5.96
85.61	18.56	–12	5.24
95.39	19.54	–6	3.96
101.28	20.13	0	2.41

Figure 6 shows the working characteristics of the safety mechanism – the change in the working force depending on a stroke of the working link. By comparing the results of the working characteristics of the mechanism with the desired characteristic, we conclude that there is a certain deviation. The curves intersects at 1/3 of the stoke of the working link and have the same maximum, approximately 6 kN. At the beginning of the motion, and up to the 1/3 of the stroke, the analyzed mechanism has lower value of working force, which is significant. By moving the working link further, the force decreases, but all the time has higher values than

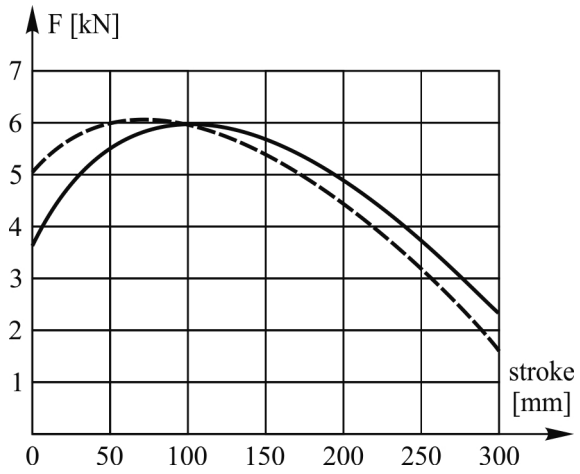

Fig. 6. Working characteristics of the analyzed mechanism; the dashed-line curve represents the desired characteristic

prescribed. Therefore, it is necessary to examine the stiffness of the spring and the influence of geometric parameters of the mechanism, which requires optimal synthesis.

5. CONCLUSIONS

This paper presents the kinematic and dynamic analysis of the safety mechanism for stubble cultivators, in case of the Horsch – Terrano cultivator. The safety mechanism of the considered cultivator consists of a 4-bar lever mechanism with an elastic element – compression spring, which allows the motion of the working link in case of overload. Based on set the requirements, the kinematic analysis was done and the characteristics positions of the working link were determined – six characteristic positions were analyzed. By dynamic analysis of the kinetostatic equations were formed. Based on this, values of the force on the working link, during the whole motion, are determined. By comparing the results of the working characteristics of the mechanism with the desired characteristics, we conclude that there is a certain deviation. The curves intersects at 1/3 of the stoke of the working link and have the same maximum, approximately 6 kN. At the beginning of the motion, and up to the 1/3 of the stroke, the analyzed mechanism has lower value of working force than the prescribed, which is a significant advantage. Although, by moving the working link further, the force decreases, but all the time has higher values than the permitted value. Therefore, it is necessary to examine the stiffness of the spring, as well as the influence of geometric parameters of the mechanism, which requires optimal synthesis.

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Cutting Forces in Interrupted Hard Turning

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Abstract

The paper presents the parameters that determine the variability of the cutting conditions in the turning process. The experimental results are given for the measurement of the cutting forces during turning of steel Č 1530. The experiment was done on the TNP 160 Prvomajska turning machine using insert CNMG 120408 HA. The insert was clamped into the PCLNL 3225M12 tool holder. Three 120-mm HBM sensors (measuring strips) are connected to the MGCPlus measuring device with an A / D transducer from the cable holder. Values of force components are calculated in relation to the deformation shown by the metering strip.

Keywords: turning, interrupted cutting, forces

1. INTRODUCTION

Today's machining processes become more and more demanding and complex, both in terms of the cutting process and in the machined surfaces of the product. Although turning is considered a process with unchanging (continous) conditions, the absence of continuous processing conditions in turning processes occur when the surface layers are removed and the "core" is removed and has certain geometrical irregularities resulting in variable conditions. Furthermore, in the finishing processes, and in the processes coming after heat treatment ("hard-machining"), the traces of the passage of the rough processing tool also generate variable turning conditions in finishing cuts.

Realizing such processes (so-called discontinuous cutting processes) in which simultaneously achieving more significantly different edge loading conditions, machining becomes as a technologically demanding task. The condition of the contact between cutting edge and workpiece can be categorized in three states (no cutting condition, entry / exit from the cutting contact, cutting). These three completely different processing states generate discontinuity in machining operations.

Hard turning of steel components is increasingly being used as a replacement for grinding operations, and furthermore, these processes offer high flexibility, greater cutting depth, and even the ability to dry processing [1] comparing with grinding.

The problem of hard material processing assumes additional requirements for cutting tools as well as on machines, especially on their stiffness and the reduction of the vibration effects that are the preferred generator of changing conditions in turning. Beside vibration

as a direct generator of variable cutting conditions, as the second generators of variable conditions by cutting in turning can be: geometric deviations of the previous processing operations (casting, forging, dragging etc.) result in varying cutting depths (and hence the variable cross-sectional area of the chips) directly affects oscillation in the value of cutting force components. Discontinuous cutting processes can be caused also by the geometry of pre-treated surfaces that contain proper and / or irregular openings in their structure, lubrication channels, various functional grooves and pockets.

The third possible generator of variable cutting conditions is heat treatment that generates thermal (geometrical) deformations specially in the thin wall products as well as inhomogeneity of the heat modified surface layers (surface layers have different hardness at the start / end of the induction hardening).

The fourth possible generator of variable conditions is the transition from rough to final machining, i.e., the relation of the value of the feed f in the previous and subsequent passage of the cutting edge. Namely, the different values of walleys in rough machining and finishing can lead to a situation where the cutting edge in the intervals crosses the hills (large ap) and walleys (small a_p) which will be explained in more detail later in the paper.

Due to all above mentioned situations, there are some limitations in the application of hard turning when machining hardened steel with non-continuous (interrupted) surfaces. Tools that are mainly used for hard turning are hard (possible fragile) and have very low impact resistance, which are typical for the processing of heat untreated surfaces. With the development of new technologies and materials, tools such as cubic boron nitride (CBN), cutting ceramics, and light-weight carbides have been found, in which hard layer processing that are heat treated, hardened and nitrated coated are becoming more and more acceptable. When turning, the edge of the cutting tool is continuously exposed to very high thermal and mechanical variable loads. The aim of this study was to determine the dynamic loading condition on the cutting tool edge while continuous turning of steel Ck45 (Č 1531).

2. CONTINUOUS VS. INTERUPPTED PROCESSES

2.1. Variable processing conditions

No cutting process can be said to be carried out under ideal constant processing conditions. There are always certain deviations in relation to the parameter set values. As an obvious example, the machining conditions during the contact of the cutting tool and workpiece are not constant during the phases of entry and exit from the operation (Figure 1) where the two parameters of the formed chips (b and h), or the parameters a_p and f has been intensively changed. However, for machining processes where relative changes (oscillations) become lower values are said to be processes with constant processing conditions, and for those with relative changes (oscillations) of higher value parameters, are said to be processes with variable conditions.

As stated in the introduction, there are several reasons for generating changeable turning conditions. One of the reasons for this is that the processing conditions can be significantly changed: turning processes in which the depth can be changed.

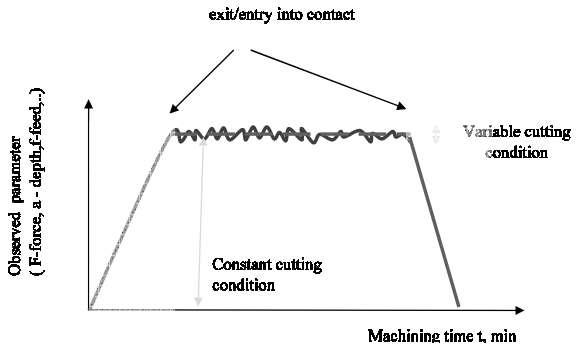


Fig. 1. Variable cutting conditions

Discontinuous cutting processes are the source of vibrations that are the result of discontinuity in the process of particle separation. Examples of such processing are the

processes with periodic variation of the cross section of the cutting area, interrupt cutting during the processing of the gear circumference, interrupt cutting of the blades arranged per circumference, the processing of the eccentrically mounted shaft or the internal processing of the asymmetric hole.

In the case of forced vibrations, the biggest problem is the possible appearance of resonance, and the same can be caused by summing elastic deformations of the tip of the cutting edge, which increases the oscillation amplitude and generates the restless operation of the machine. The occurrence of large amplitudes can occur if oscillations (elastic deformation) are not damped from the previous impact, and before a new shock occurs. If the impulses are dense, the image is similar to the sinusiodal excitement.

To similar findings become D. Bachrathy and I. Mészáros [2] (Fig. 2) in studying dynamic problems in interrupted, very precise hard turning.

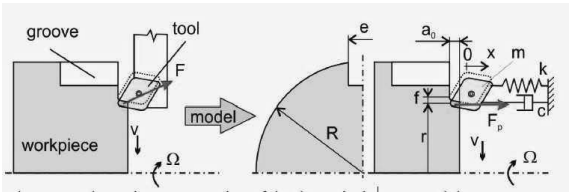


Fig. 2. Shematic show of dinamic system and parameters [2]

Emphasis has been put on the study of the vibration occurring during processing and has a significant impact on the size of the cutting force and the quality of the treated surface. The time period of each phase is marked, the cutting cycle Trez and the Tfly for the phase without touching the blade with the machining surface.

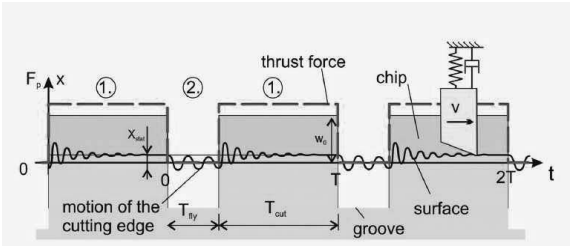


Fig. 3. the variable cutting conditions and tool vibration accurance [2]

3. CUTTING FORCES COMPONENTS

Cutting tool can separate parts (particles) from the surface of the workpiece if the tool acts on workpiece with cutting force F with values that overcome cutting resistances and friction forces. In the literature [3], the cutting force vector is disassembled to the forces of cutting by means of the equilibrium circle of forces, and the calculation of the individual components is also defined in terms of orthogonal cutting. F_c, F_f , F_p are the three components of force most often shown in the literature, and their vectors are oriented in the direction of cutting speed, feed and cutting depth (v_c, f, a) of Figure 4.

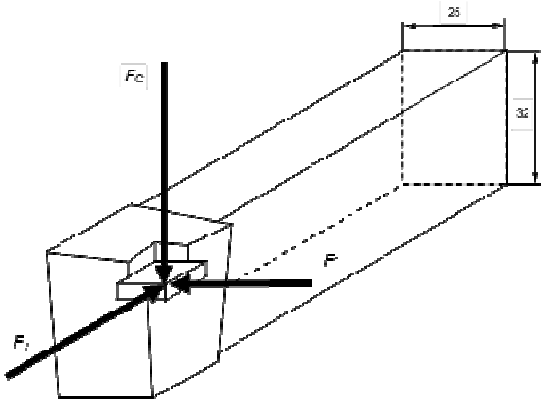


Fig. 4. Force components on turning tool [3]

Changing of the cutting depth and feed ratio, tool geometry (κr, δ, tool tip radius), increasing of tool wear and mechanical properties of the workpiece significantly affect the values of the individual components of the cutting force. Research results are very often only applicable to certain combinations of input conditions and shapes of wear because the differences in the ratio of the individual components of the cutting force under different conditions are too high. Major changes in force component ratios during cutting may be due to changes in processing parameters (variable depth of cutting in castings, wrought, over welded and heat threaded workpieces), so the exact ratio is very difficult to define.

4. EXPERIMENT

The work piece on which the tests were performed is made of the steel group for hardening. Steel was heat treated to achieve better mechanical properties. With heat treatment martensitic microstructure by cross section has been achieved, i.e., better hardness profile in depth (Figure 5).

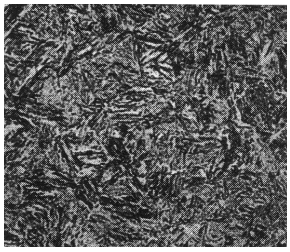


Fig. 5. High-grade martensite in steel microstructure (amplification 500x) [4]

Table 1. Results of deformation and stresses obtained on the cutting tool model

Steel designation		Chemical composition (%)							
DIN	HRN	C	Si	Mn	P	S	Cr	Mo	Ni
C45	Č1530	0,45 to 0,50	≤0,40	0,50 to 0,80	<0,045	<0,045	<0,4	<0,10	0,40
Mechanical properties									
diameter:		hardness		strength (R_m)		strength ($R_{p0,2}$)		elongation (A_5)	
40-100 mm		max 255 HB		630-780 N/mm^2		min 370 N/mm^2		min 17%	
Heat tretment:									
Normalisation:				1100 - 850°C/air					
Soft annealing:				680 - 710°C					
quenching:				820 - 860°C/water, oil					
tempering:				550 - 660°C/air					

The test sample was heat-treated by quenching at 860°C and annealed at 660°C. The test sample was a slotted rod of 70 mm in diameter and 150 mm long with a grove of 8 mm wide and 10 mm deep (Figure 6) [6]. Groove had the purpose of obtaining so-called "interruption turning" during machining.

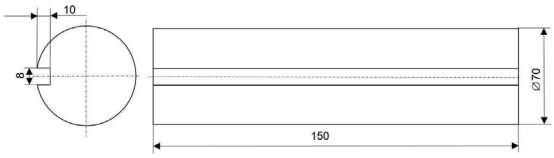


Fig. 6. Test sample geometry

Figure 7 shows the work piece in which the tests were carried out. Wokpiece was machined with different regime setups. Each regime setup influence has been analysed separetely as a single measurement [6]. In total 27 measurements were made and three force component were measured. Some results are presented in the paper. The turning process was carried out with carbide insert (TM), the designation CNMG 120408HA (NC 3220) and of producer Korloy. The dimensions of the insert are: l=12.0 mm, t=4.76 mm, r=0.80 mm, d=12.70 mm, d_1=5.16 mm. The recommended cutting parameters for this insert are: a_p=0.8 mm till 3.50 mm, f=0,01 mm till 0,4 mm. The PCLNL 3225M12 tool holder was used.

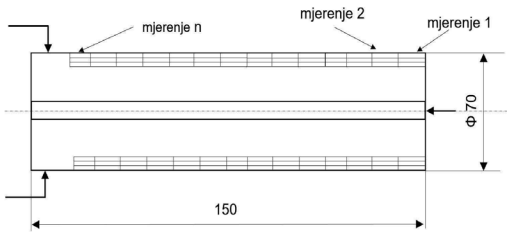


Fig. 7. Sketch of the test sample with marked measurement locations

The sensors (strain gages) were connected to the MGCPlus measuring device, which contained a 24 bit A / D inputs and converter on each channel when measuring force components. During the machining and recording of the mesured values, the sampling frequency was 1000 Hz. The capabilities of the devices are up to 19.2 kHz per channel. The schematic representation of the measurement is shown in Figure 8. The force was measured with three sensors (measuring strips) of the HBM type of 120 □. The signal analysis was carried out using Computer Expert Application Design.

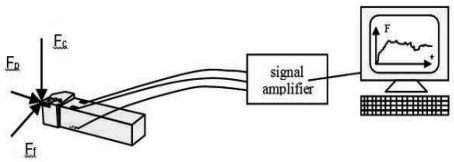
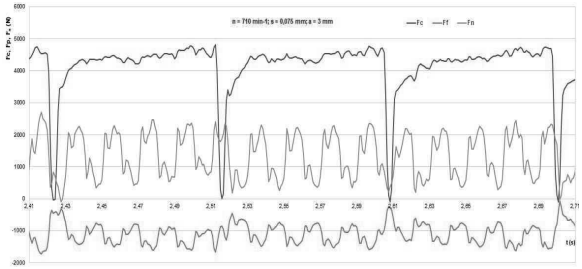


Fig. 8. Force measurement setup [7]

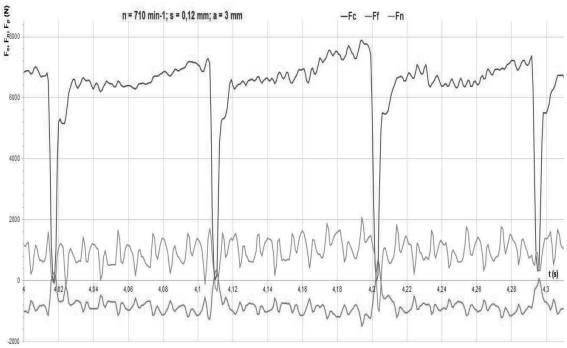
For measurement number 1, the processing parameters were: f = 0.075 mm, a_p = 3 mm, n = 710 min^{-1}. The diagram of measurement results for this setup was shown in Figure 9. On the diagram of the main force of cutting Fc, there is a very significant, sudden fall of the force value . That part of the curve represents the time interval when the cutting edge was not in contact with workpiece, but is in the groove. The values of the individual forces are visualy reapeted in cycles during entire measurement, so for all of the following illustrations, the values of the force components are shown in only three revolutions (three cycles).



Note: In the image, the force values for component F_f are displayed in the negative area for better visibility

Fig. 9. Force values during measurement nr 1

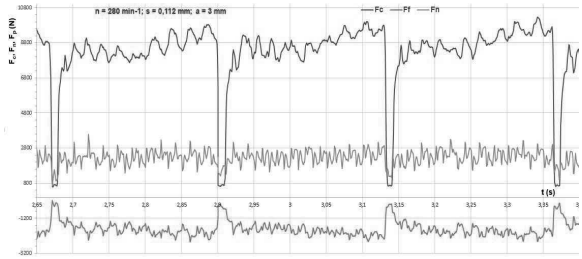
The picture shows that the influence of the variable cutting depth (a_p=0 mm during the passing of the edge through the groove and ap ≠0 mm for the rest of the time) can be visualy recognised by observing the force component F_c. For measurement number 2 processing parameters were: f=0.112 mm, a_p=3 mm, n=710 min^{-1}. The diagram shown in Fig. 10 shows the values of the force for measurement nr 2.



Note: In the image, the force values for component F_f are displayed in the negative area for better visibility

Fig. 10. Force values during measurement nr 2

For measuring no. 3, the machining parameters were: f = 0.112 mm, a_p = 3 mm, n = 280 min^{-1}. The diagram shown in Figure 11 shows the values of the force for measurement nr 3.



Note: In the image, the force values for component F_f are displayed in the negative area for better visibility

Fig. 11. Force values during measurement nr 3

5. CONCLUSION

The study of variable cutting conditions was analyzed by measuring the cutting force components. Test sample with milled groove has signifact influence on variability of cutting depth and on main cutting force. The measuring diagrams in Figures 9 through 11 show the most noticeable influence of the variable cutting depth (a_p = 0 mm during the passing of the cutting edge through the groove and $a_p \neq 0$ mm for the rest of the time) if the force component Fc is observed. According to the results of the measurements it can be concluded that for the larger cross section of the undeformed chips, greater cutting force is needed to separate the chips from the work piece.

For equal cross section of undeformed chips, as is the case for measurement number 2 and measurement 3, it can be concluded that greater cutting force occurs at loweer cutting speeds. It is precisely visible during measurement nr 3. and if observed force component is F_c. Therefore, the maximum value of the cutting force was obtained during

the regime setup with the smallest cutting speed and the largest cross section of the undeformed chips. The minimum cut-offcutting force value was obtained during the machining with minimum cutting depth, minimum feed and maximum speed.

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Modelling and Simulation of Deformation of Cutting Tool during Cutting

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Abstract

This work simulates the stress and deformation of the tool holder for turning and determines the elastic deformation value of the tip of the cutting insert. Cross-section of tool holder was 32x25 mm and holder with cutting insert were modeled in SolidWorks. The ANSYS structural analysis software was used to simulate the load using the finite element method. Two size elements of the network are selected. One network has elements with size of 5 mm, and the other is a mesh with size of 1 mm. The simulation was carried out for five different values of force acting on the model. Each of these 5 values of forces was carried out through simulation on the above-mentioned two different finite element network arrangement.

Keywords: FEM, cutting tool, deformation, optimisation

1. INTRODUCTION

Metal cutting (machining) is one of the processes for obtaining a functional geometry and shaping of the products. It is estimated that significant value of all machine elements functional surfaces is derived from machining operations. However, despite its obvious economic and technical importance, machining remains one of the least predictable manufacturing operations due to the fact that the machining models are complicated for defining. The geometry of cutting tool surfaces is one of the crucial parameters affecting the quality of manufacturing process.

When machining metals and alloys most of the energy required to form the chips is converted into deformation of contact surfaces. Contact area between the tool and workpiece and the tool and the chip affects cutting conditions and performance of the machined surface and tool life.

Cutting is a process of extensive stresses and plastic deformations. The high compressive and frictional contact stresses on the tool face result in a substantial cutting force F as shown in figure 1.

The cutting force vector is defined in terms of orthogonal cutting. F_c, F_f, F_p are the three components of force most often shown in the literature, and their vectors are oriented in the direction of cutting speed, feed and cutting depth (v_c, f, a_p) Figure 1.

This paper analyse the problems of contact between tool and workpiece simulating the

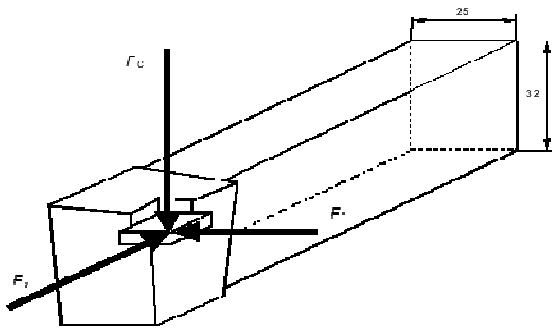


Fig. 1. Force components acting on turning tool

loading (and stresses distribution over tool holder) and deformation.

2. CUTTING TOOL MODELING

For the simulation of the load, it is necessary to create a 3D model of the cutting tool we are exposing in the simulation. In this case, the 3D model consists of two merged bodies: an external turning tool holder and a cutting insert. The dimensions of the model are defined by the dimensions of the real holder and the insert. In this case, it is the Corloy CNMG 120408HA (NC 3220) insert. The dimensions of the insert are: l = 12.0 mm, t = 4.76 mm, r = 0.80 mm, d = 12.70 mm, d1 = 5.16 mm. The insert was inserted into the PCLNL 3225M12 toolholder. The holder and the insert are modeled in the package SolidWorks.

After designing the model of the holder and the insrert, a new phase is opened in which the two models will be merged to the body required for the simulation. The body has been assembled in the way that the model of the holder is placed first as a fixed part inside the space. Next, a insert model is added to the definition of space on the basis of the fixed holder model. Then we define the contact surfaces between the parts (holder and insert) of the model and thus define the position within the space. To obtain accuracy of modelled stresess and deformation during simulation, it is necessary to merge all the contact surfaces to each other because the forces in reality are transmitted over all of these surfaces. The model, along with the defined contact surfaces, is shown in Figure 2.

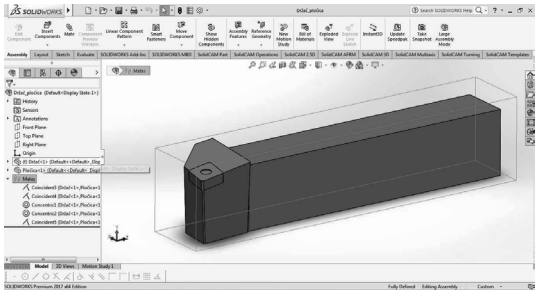


Fig. 2. Model of cutting tool holder with insert

3. MODELING OF TOOL LOADING

The ANSYS structural analysis (ANSYS structural analysis) software was used to simulate the load using the finite element method. Using of the program is not complicated [2]

For modeling the load and simulating the deformation size, a static structural analysis tool was selected.

Using ANSYS software - structural analysis, it is possible to solve complex problems and propose better solutions. The software uses technique of finite element analysis. This method enables simulation of problems in multiple scenarios and with different parameters. This tool is used in almost all industries and enables product optimization and cost savings caused by physical tests. [3] Since the model of the tool has been made in SolidWorks, model geometry needs to be loaded (Import Geometry).

The loaded model is shown in Figure 3. In the window you can change the model and define the other settings required for the simulation. For each step, or name, it is

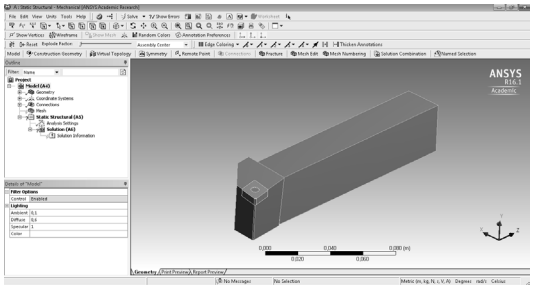


Fig. 3. Imported model of cutting tool into ANSYS package

necessary to define the settings correctly so that the simulation succeeds. The cutting tool model needs to be set in a specific space and define Connections, also shown in Figure 3, contains all of the contact surface joints defined when creating a CAD model in SolidWorks.

After that, the network of finite elements is defined in the work area. After generating the network, the model is displayed with the network of generated finite elements. By choosing a smaller size of elements, a model with a flawed grid is obtained, ie the model has multiple elements. Also, by choosing the finer elements the results obtained by simulation are more accurate. For comparison purposes, two dimensions of the elements were selected for this work. One net is less common (popular) with the size of the 5 mm elements, Figure 4 and the other the mesh is louder with the size of the 1 mm elements, Figure 5.

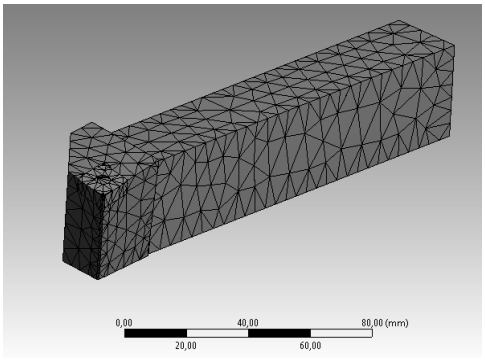


Fig. 4. Spreading of FEM mesh over the cutting tool, 5 mm

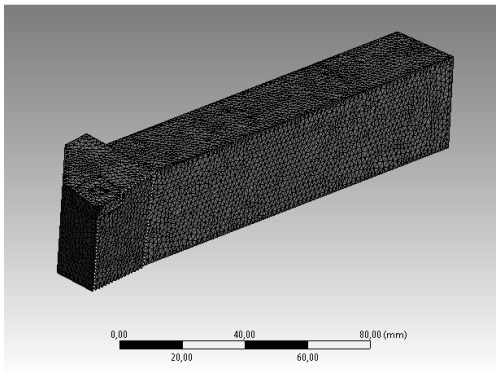


Fig. 5. Spreading of FEM mesh over the cutting tool, 1 mm

The first of the two conditions to be placed on the model is Fixed Support. This is the surface that is fixed during the simulation in the space. In reality, this surface is equivalent to the surface to which it is attached during real load, ie that surface represents the stand of the model in the space. For the working model, the surface on the underside of the bracket was selected as a fixed surface. When designing a CAD model, this surface is defined with the intention of being used as a support during simulation. The holder is fastened to the machine during turning and the bottom side is attached to it. That is why the fixed surface is defined from the bottom of the model. Figure 6 shows the selected fixed area.

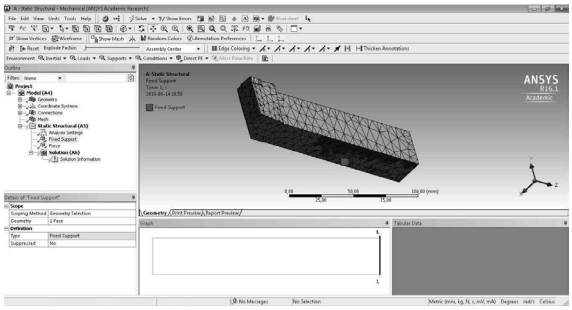


Fig. 6. Fixed surface of the model

The action of force is directed to the surface defined when making a CAD model at the top of the insert. This surface represents the surface of the plate that is in contact with the work piece during the turning. So the forces that occur during the process work on that surface. The forces are set in the direction of all three axes. The amount of force and direction will be shown in the pictures below.

Before the simulation starts, it is necessary to select the desired results. Of course, as many items are selected, longer simulations will last because of the greater amount of math problems that need to be solved. For this work two items have been selected, ie two types of data / results to be displayed. These are data on overall deformation and strain. The icons "Total Deformation" and "Equivalent Stress"

For simplicity, the equal values of the cutting force components in the direction of the x and z axis were selected (in reality, the passive and shear components of the cutting force). The highest value of the force is in the direction of the axis y, which is also in real load conditions.

4. RESULTS OBTAINED AFTER SIMULATION

The simulation was carried out for five different values of force acting on the model. Each of these 5 sums of forces that was carried out through simulation of the above-mentioned two variants of the finite element mesh arrangement.

The cutting deformation (δ) of the cutting edge is particularly important as the size of the deformation affects the machining accuracy, as well as on other geometrical size tribology processes on the cutting tool's contact surfaces. For this reason, only the size of the deformation will be presented in simulation results. deformation values δ_5 and δ_1 are obtained for different FEM mesh size 5 mm and 1 mm respectevely.

Table 1. Results of deformation and stresses obtained on the cutting tool model

Meas. nr	Total force F, N	Fc, N (Fy)	Fp,N (Fz)	Ff, N (Fy)	FEM - mesh size 5 mm		FEM - mesh size 1 mm		Δ (δ_5- δ_1), %	Δ (σ_5- σ_1), %
					Deform. δ_5, mm	Stress σ_5, MPa	Deform. δ_1, mm	Stress σ_1, MPa		
1.	966,6	900	250	250	0,029264	1583,1	0,030605	1899,3	4,38	16,65
2.	1510	1400	400	400	0,045232	2448,4	0,047321	2978,9	4,41	17,81
3.	2053	1900	550	550	0,061202	3314	0,064039	4058,8	4,43	18,35
4.	2596,2	2400	700	700	0,077172	4179,6	0,080758	5138,8	4,44	18,67
5.	3139,3	2900	850	850	0,093142	5045,3	0,097477	6218,8	4,45	18,87

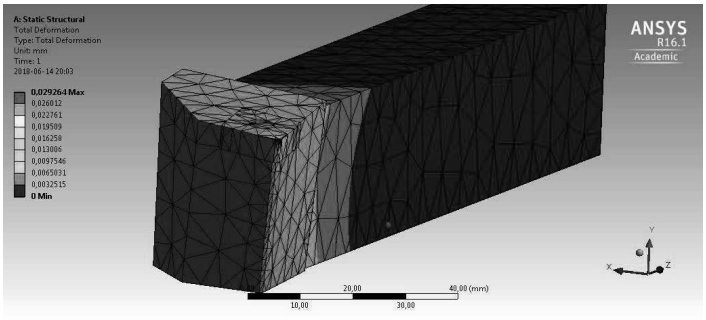
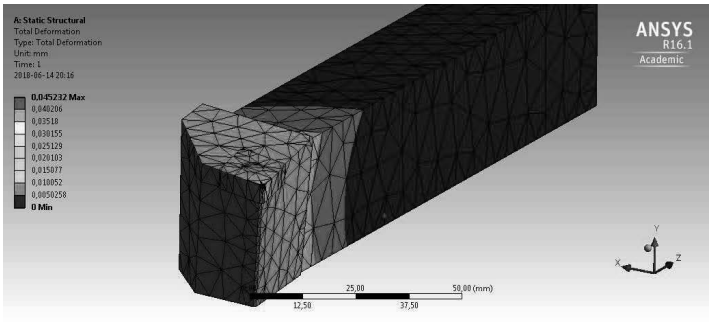
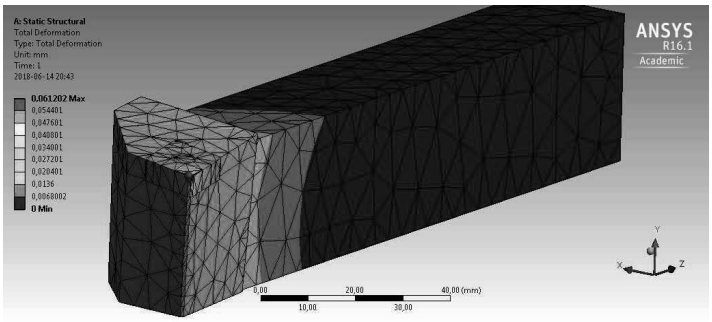
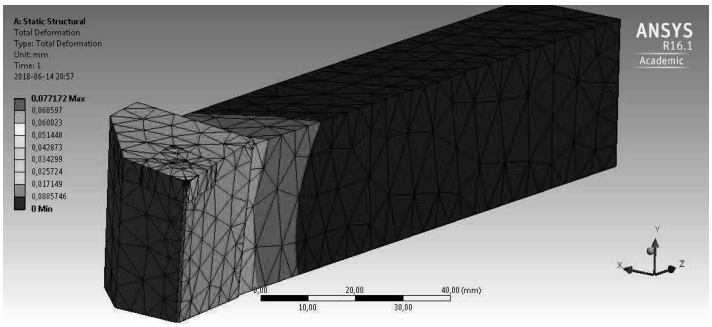
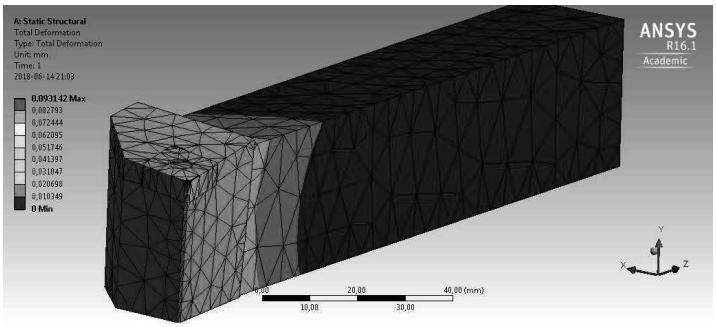
Table 1 shows the results for five different load combinations (five values of loading) and for different FEM mesh size (two mesh size). The picture of deformations shown in table 2 shows that the greatest deformations appear at the very top of the inserts, exactly where the force acts. In the area of cutting tool support, they do not even appear because they are rigidly fixed. As with deformations, even the largest stress concentration is created at the site of action of force. Table 1 shows that the results with the fracture network are slightly different, or higher than those of the previous ones. The reason for this is just the amount of elements that are smaller in size on the model. Thus, the results are more precise, mathematical calculations take into account the fewer surfaces. For example, taking the 5 mm element size from the previous case, it may be that one part of the element is more stressed than the other part. Reducing the size of the elements partially removes this effect and yields more accurate results. But it is also apparent that the differences in the model obtained deformations are less than 5% (Table 1) which can be considered as sufficiently accurate if a mesh with larger elements is applied.

5. ANALYSIS OF RESULTS AND CONCLUSIONS

The results shown above and obtained by simulation of the deformations and stresses of the cutting tool using FEM analysis are expectable during real machining conditions. The obtained values of deformation are relatively small comparing with cutting tool model size, but the software has the possibility of increasing them for a better visual display. More important regarding deformation values is that they do not greatly affect the dimensions of the workpiece.

From the results shown in this paper, it is evident that the increase in the force acting on the model increases and the deformations and stresses. In reality and so, if a body is loaded with higher force, it will become more deformed. Stresses also have a direct proportionality to the force when have been calculated. Greater the force on the same size cutting tool model means higher stress and higher deformation.

Table 2. Demonstration of deformation (δ5) distribution over the cutting tool model

Meas. Nr	Total force F, N	Deformation values δ_5,mm
1	966,6	
2	1510	
3	2053	
4	2596,2	
5	3139,3	

It is also apparent that the differences in the model obtained deformations for different FEM mesh element size are less than 5% which can be considered as sufficiently accurate if a mesh with larger elements is used because of its very fast results obtaining.

It can be also concluded that the results obtained by the simulation even without the use of the machine have real values and are usefull for process optimisation. Without the realization of the turning process in real, this simulation offers the values of deformations and stresses that occur during the real cutting process. This is very important and useful specially for optimizing the cutting process. During the simulation, the model can be subjected to various forces and processing modes without the risk of damage and material distroying. Gradual changes in the regime parameters after its checking in the real process offer that the result of simulation result with optimal values that can be afterword used in real process. By optimizing the process in reality instead of on a computer, we will spend a loto f time, generate greater material consumption and, most importantly, there is a risk of fractures and failures due to wrongly selected regime parameters.

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Ultrasonic Measurement of Wall Thickness

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Abstract

The paper describes the method of ultrasonic measurement of the thickness of the wall. The work consists of a theoretical and practical part. Theoretical part describes methods of non-destructive control with an emphasis on the ultrasound method. The principle of ultrasonic measurement of wall thickness and the equipment used for ultrasonic testing are described. In the practical part, a wall thickness measurement was performed on the tank. The tank was already in operation and then changed for other purposes. After the restoration of the tank, we measured the thickness of the walls on each of the sanitized parts. Attention was drawn to the eligibility criteria and the tolerance prescribed by the norm. Based on the practical work, the results were analyzed and a conclusion was drawn on the advantages and disadvantages of this method.

Keywords: ultrasound methods, ultrasonic equipment, thickness measurement, tolerance

1. INTRODUCTION

Quality Control is a set of methods and procedures by which the quality criteria determine compliance and meet the requirements set. Quality control is a fully standardized approach.

Depending on the types of tests carried out on the material and the welded joints, the quality control is divided into destructive control and control.

Non destructive control contains all methods of test and measurement which, by their application, do not affect the functionality of the tested object. Destructive control methods provide data on the condition of the test object (surface quality, volume quality, grade of weld quality, etc.).

The basic division of non-destructive methods is on surface and volume. Surface methods give data on the surface state of the test object and are divided into visual, penetrant and magnetic methods. Volumetric methods provide data on the volume state, ie the interior of the test object, and are divided into ultrasound and radiographic methods. Of the other methods that do not belong to these groups, it is often used to extract acoustic emission, vortex currents, leakproofness control, isolation testing on improperness and hardness measurement.

In this paper an ultrasound method of wall thickness measurement will be analyzed. The aim of the paper is to describe the mode of operation and to demonstrate the use of ultrasound on a specific example. The work will be divided into theoretical and experimental part.

In the theoretical part will be described the principle of the ultrasonic method, the physical basis of ultrasound and ultrasonic sources. I will be dealing with ultrasonic waves and ultrasound parameters as well as reflexion and fracture of ultrasonic waves and parts of the beam. Special attention will be paid to ultrasonic probes, device and signal mode. When measuring the

thickness of the wall, I will talk about the choice of ultrasonic equipment and measurement techniques, surface condition and test personnel.

The experimental section will show the wall thickness measurement on a tank that was already in use. Ultrasonic measurement will be used when assessing the actual condition of the object. According to the state of the surface of the test object, a suitable test technique and an ultrasound system will be selected. According to the analysis of the results of the experimental work, conclusions will be drawn on the advantages and the lack of this method.

The paper will use expert literature on ultrasound control, Croatian and European standards

2. ULTRASONIC CONTROL

The principle of ultrasonic control is based on the transmitting of the ultrasonic wave to the material, it is repelled from the obstacle and the time required to revert the wave determines the distance and shape of the object or some irregularity in the material. Ultrasound is a sound whose frequency is above the upper limit of hearing for a normal human ear, which is 20 kHz. The average human sound is 16 Hz to 20 kHz.

Transmission and reception of the ultrasound into the test material is carried out by ultrasonic transducer and ultrasonic sensor. The ultrasonic wave pulses through the pass through the probe and the material we measure, and such a signal in the device is precisely measured as the time of passing through the metering object.

2.1. Physical basic of ultrasound

Acoustics is an area of physics dealing with the study of phenomena related to the formation, transmission and reception of sound or related tonsils in a wide spectrum of frequencies and applications. [1]

Sound is generated by vibration, mechanical titration, some matter. Titration is the form of periodic motion caused by elastic body traits, repetition of a series of states at certain time intervals (intervals). The parameters we use to describe the titration are:

- period T, time of one titre
- frequency f, number of titers per second
- elongation x(t), shift from equilibrium position at time t
- amplitude A, maximum elongation

Free titration is the periodic motion of the body caused by the action of elastic force proportional to the displacement of the body from the equilibrium position (Figure 1.). The total energy of the free-titrating body equals the sum of its kinetic energy and elastic potential energy. [2]

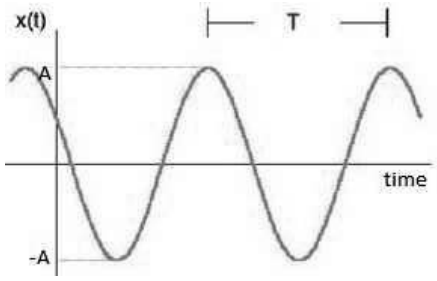

Fig. 1. Graphic view of free titration

2.2. Ultrasonic sources

The ultrasonic titration in the contact with the agent will transfer the titration to the surrounding substance. The particles in the ultrasound device excite titers with the same frequency as the source, but with a different phase. The titration phase depends on the rate of titration and the point in the space where the state of the titration is observed. [1] The wave velocity is calculated according to the expression:

$$v = \lambda \cdot f \qquad (1)$$

where:

- v velocity of wave propagation, m / s
- λ wavelength, m
- f frequency, Hz

2.3. Creating ultrasound and ultrasonic waves

The ultrasound probe by pushing on the object transfers the titrating into the means they

are in contact with. An integral part of the transducer is a titrator that generates ultrasonic waves due to various external stimuli.

Ultrasonic waves can only be spread in a homogeneous medium, and this is precisely the basis for detecting errors in the object being investigated. Waves at the boundary of the medium, whether it is the walls of the test object or the irregularities within the material, follow the legitimacy of the wave motion. The proper interpretation of the ultrasonic energy obtained by tracing the test material can be used to estimate the material condition and the parameters of the detected errors.

Ultrasonic energy is the most commonly used piezoelectric effect, and is based on the ability of some materials to generate electrical potential when subjected to mechanical pressure. When such material is processed appropriately, the active part of the inverter that can produce and receive ultrasound is obtained. Other ways of getting ultrasound are: magnetostrictive, mechanical acceleration, thermal stimulation, electrostatic, electrodynamic.

Ultrasonic waves transmit the energy of titration through the material. Depending on the type of material through which energy is transmitted and features such as the type of material, shape and dimensions, and the elastic properties of the material, various types of waves will occur.

There are two basic types of waves, which are longitudinal and transversal. Longitudinal waves are those waves in which the particles are titrated in the direction of wave propagation, causing dampening and dilution in the widening medium. Transversal waves are those waves in which the particles are titrated perpendicularly to the direction of wave propagation, and do not cause dampening and dilution in the medium being widened. Longitudinal waves can be spread in all three aggregate states, while transversals can only be spread in rigid media.

Of the other waves used in ultrasonic control, the most important surface and plate waves are the combination of longitudinal and transverse titers in the medium. Most used are Rayleighs, Lateral, Lambs and P-waves.

Ultrasonic waves spread in their original form only in infinite means. Since in practice the means are limited by dimensions, the infinite means is considered only as a means whose dimensions are considerably larger than the wave wavelength expanding. By analyzing response, ultrasonic waves returning from the boundary of the media, we can detect errors in the test object.

For all waves Snell's law is valid, which is calculated according to the expression:

$$\frac{\sin \alpha_1}{\sin \alpha_2} = \frac{v_1}{v_2} \quad (2)$$

where:

- α_1 is the angle of propagation of the sound in the medium 1
- α_2 is the angle of spreading sound in the medium 2
- v_1 speed of sound in the media 1, km / s
- v_2 speed of sound in the media 2, km /s

2.4. Ultrasonic probes

Ultrasonic test probes are a key part of the ultrasonic system. When constructing the probes, the following is taken into account: inverter material, electrode configuration silencer and its features, prism and / or mask for transmitting ultrasound to the material, housing, protective elements and masks.

In practice, the usual division of probes toward the direction of transmitting and receiving the ultrasonic beam in relation to the object of the test, the mode of excitation, the technique of work and the like. Standard probes used in manual ultrasonic control are: flat, double and angular probes.

The ultrasonic device consists of electronic components that allow the operator to detect the irregularities of the test object in structure and dimensions by ultrasonic waves. The ultrasound device produces high-voltage and short-life electrical pulses, which convert the

piezoelectric transducer into the test probe into mechanical oscillations in the ultrasound field. These oscillations are in the subject of the test as sound waves. The sound waves are reflected on the boundary surfaces and the transducer of the test probe receives them and is displayed on the ultrasound device screen

3. MEASUREMENT OF THE THICKNESS OF THE WALL

Ultrasonic wall thickness measurement is used in the industry to carry out precise measurements on various types of materials, parts and components.

It is useful to monitor the wall thickness of various types of pipes and pressurized vessels in exploitation, for comparison of loss of projected thickness, bearing capacity of corrosion-induced corrosion or erosion. The principle of ultrasonic wall thickness measurement is based on measuring the time required for a short ultrasonic pulse to pass through the material one or more times.

The thickness of the material is calculated according to the expression:

$$d = \frac{v \cdot t}{n} \quad (3)$$

where:

- d the thickness of the material, m
- v known ultrasonic velocity in material, m / s
- t measured time pass through material, p
- n the total number of impulse passages through the material

If measurements are performed in steel, standard measurement methods can be measured in thicknesses of 1 mm to 10 mm.

The choice of probes depends on the type of equipment, the thickness of the material, the condition of the surface and the possible coating on the surface.

It is imperative to use a contact agent to compensate for roughness and roughness in the contact probe - material. The contact materials are most often viscous, non-toxic gels or oils which, by their structure and properties, do not substantially affect the ultrasonic pulse and at the same time ensure good contact between two different materials. The contact medium should be applied to the test surface in a thin layer. Layer thickness can affect test results and signal stability on the ultrasound device.

We use etalone and reference samples to check the characteristics of the equipment and to adjust the ultrasound system. When measuring the wall thickness, the measuring system should be calibrated on one or more reference samples, and the thickness of the material or the ultrasound velocity should be known for proper calibration.

The surface of the test object must be accessible and cleaned of dirt, grease, oil, without damaging the electrical arc or splash and without residues of corrosive products. Optimal measurement results are achieved on a clean, preferably wiped, surface.

3.1. Experimental part

The experimental part will explain the method of measuring the thickness of the wall on a tank that has been in use for a number of years, and is now overwhelmed by cement storage. Ultrasonic measurement of the wall thickness was used when assessing the actual condition of the object.

To measure the thickness of the wall, the handheld device PosiTector UTG C - Standard, manufactured by DeFelsko (Figure 2), was

Fig. 2. Test device and contact lenses

used. The device is designed to measure the thickness of metal and nonmetal, and uses the technique of single-sided measurement in its work. As a contact agent, a DeFelsko manufacturer's gel was used which is chemically neutral and can be used at temperatures from -15 ° C to 104 ° C.

In our case there was no technical documentation, it was not known from which material and the thickness of the test object was made. Due to experience with similar objects of similar use, it was assumed to be a structural steel, of S235JR or less, in a sheet thickness of 3 mm to 8 mm. Two-point calibration was accessed. For the purpose of the test, reference samples of 3 mm and 8 mm thick were cut. The two-point adjustment is based on calibration at the lower thickness and then on the upper. For proper reading of measured thickness results must be within these two limits.

The measurement results show that the first two sheaves, up to the funnel, were made from a thickness of 6 mm, the other two from a thickness of 5 mm and the last two from a thickness of 4 mm. After that, the device calibrated to the thickness to get the most accurate result and started with the test.

The test facility has been outdoors for a number of years, so the influence of atmospheric conditions left a trace on its surface. In such a situation the object was not suitable for measuring the thickness of the wall. The exact initial surface area assessment was performed by visual inspection according to HRN EN ISO 8501-2 [3] and the following was concluded:

- interior surface - the coating has been damaged with little or no rust
- external surface - the coating at the places began to separate, part of the surface began to rust, and a localized occurrence of deep corrosion

In both cases it was decided that the previous coatings and rusts were completely removed according to HRN EN ISO 8501-1 [4]:

- interior surface - thorough manual and machine cleaning, level of primary surface preparation by manual cleaning method St 2
- external surface - very thorough cleaning with abrasive blasting, level of primary surface preparation with abrasive cleaning method Sa 2½

After the surface preparation (Figure 3) there was another visual inspection of the object.

Fig. 3. External surface after cleaning

The tank bulkhead is worn out and the need for a different type of opening is replaced by a new one, and the roof is reinforced with a ribbed lime. At certain sites, a phenomenon of deep corrosion has been observed which could be the potential cause of loss of the basic thickness or design capacity of the facility. By grinding and polishing on one characteristic part and then by measuring the thickness of the wall, it has been found that remedies can be performed in this way and that loss of thickness is within the tolerance set. All other critical sites were remedied in a similar way. After all repairs, the areas on which the measurement will be performed are further polished for as accurate results and as such an object was ready for the test.

The test object consisted of six sheaves with three different thicknesses of sheets, 4 mm, 5 mm and 6 mm. Each cloak was measured from the outside on 20 places, randomly selected on a clean surface (Figure 4) and additionally at any place where repairs were performed (Figure 5), which could result in up to 50 measurements per strap.

Fig. 4. Measurement of the thickness of the wall

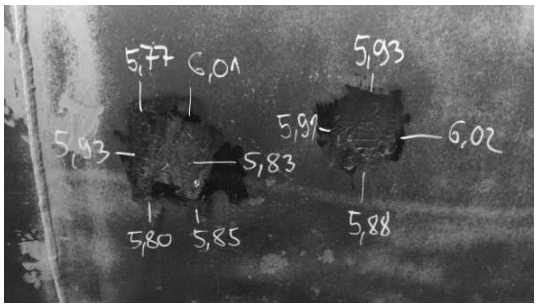

Fig. 5. Measurements on brushed parts

For hot rolled steel sheet tolerances of basic requirements should be according to HRN EN 10029 [5], tolerance of thickness class A, unless otherwise agreed. In our case, tolerances for 4 mm thick sheets are from -0.4 to +0.8 mm, and for sheets of 5 mm and 6 mm are from -0.4 to +1.1 mm (Table 1).

Table 1. Tolerances to nominal thickness

Nominal thickness (mm)	Class A	
	Lover tolerance	Upper tolerance
$3 \leq t < 5$	-0,4	+0,8
$5 \leq t < 8$	-0,4	+1,1

When interpreting the measurement results, average measurements were taken into the broken parts (Table 2). Individual spots where measured less than the permitted -0.4 mm or -0.4 mm to -0.7 mm were less than 5% of the test surface. The highest measured deviation was measured on the sheath of 3 and -0.48 mm. Places where the measured values below -0.4 mm were few meters away so that multiple faults were switched off in one.

Table 2. Results of measurement

Measuring site	Nominal thickness t (mm)	Average of measurements
Cloak 1	6	5,87
Cloak 2	6	5,84
Cloak 3	5	4,81
Cloak 4	5	4,83
Cloak 5	4	3,87
Cloak 6	4	3,89

It is concluded that the thickness of the test object is within the eligibility criteria and that the facility meets the required requirements. After the tests, the grinding parts were further dampened for better adhesion and the surface was protected with a non-metallic coating (Figure 6).

Fig. 6. The final look of the tank

4. CONCLUSIONS

Ultrasonic control is part of non-destructive testing, and applying this method to the object of the test does not affect its functionality. The first part of the paper describes the physical basics of ultrasonic control and detailed parameters of the ultrasonic method as well as the parts of the ultrasonic system.

Particular attention is paid to the method of measuring the thickness of the wall. Ultrasonic Thickness Measurement is a lightweight and fast procedure that is often used for auxiliary measurement based on which other material parameters are calculated. The choice of measurement technique and ultrasonic system depends directly on the state of the test surface, the properties of the material and the required precision measurement. Prior to the

measurement, the calibration procedure of the measuring device on the reference blocks made of materials of the same or similar properties must be carefully carried out.

The experimental section shows the wall thickness measurement on a tank already in use. According to the state of the test facility, the test technique and the ultrasonic system were selected. After surface treatment and restoration on the object, we measured the wall thickness. The criterion of eligibility was based on the tolerances laid down by European standards for hot rolled steel sheets.

By analyzing the measurement results, it was concluded that the reservoir meets the required conditions and that the use of the facility is allowed for the foreseen purposes. In this example, the importance of wall thickness measurements has been demonstrated since the measurement results can be used when deciding to continue working or rejecting the facility, so it requires seriousness and professionalism in the work and interpretation of norms.

Ultrasonic control is, in recent times, an extremely important method that is increasingly used in everyday work. In the future it is possible to further advance these methods and techniques.

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[5] HRN EN 10029: 2010 - Hot rolled steel sheets of a thickness of 3 mm or more - Permissible deviations of dimensions and shap.

Testing the Range of a LPWAN IoT RF Module Based on the Texas Instruments CC1200 Chip

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Abstract

During the deployment of wireless communication infrastructure, one of the key tests is testing the range of nodes that form the network. This paper is part of a project that explores the possibility of implementing an alternative communication system that provides a means for mobile communication even in the case of failure of the whole infrastructure of commercial mobile operators. Considering the specific application domain, the network would be deployed with LPWAN IoT-based RF modules, which, due to their low consumption, enable autonomy of operation in conditions without network power. The paper presents the results of testing the range of the selected LPWAN IoT RF modules that are based on the Texas Instruments CC1200 integral circuits as well as the method of performing the experiment. The experiment was made in the territory of Novi Sad (Serbia).

Keywords: RSSI mapping, LPWAN based communication, IoT, Sensor network.

1 INTRODUCTION

Everyday communication between people today relies heavily on wireless communications, primarily on the use of mobile phones [1] with the use of mobile data or WiFi. This paper is part of a project that explores the possibility for implementing an alternative communication system that provides a means for mobile communication even in the case of failure of the whole infrastructure of commercial mobile operators.

Considering that during natural disasters one can also expect disturbances in the supply of electricity, when selecting the RF (Radio Frequency) communication module, the emphasis was put on LPWAN (Low-Power Wide-Area Network) IoT (Internet of Things) based RF modules. These modules are suitable because of their low power consumption which allows them great autonomy of operation and battery power in conditions when there is no network power supply.

During the deployment of a new wireless communication infrastructure, after choosing the right equipment, one of the key tests is testing the range of nodes that form the network. In order to get the strength of the radio signal between two network nodes (transmitter and receiver), one of the common measures is RSSI (Received Signal Strength Indicator). RSSI is a quality measure of the signal from the transmitter and received at the receiver at the current mutual distance. Based on this measure it is possible to assess the quality of the connection between the transmitter and the receiver [2].

This paper presents the results of measuring the range of the chosen LPWAN IoT RF modules, which are based on *Texas Instruments* CC1200 integrated circuits. The modules are connected in such a way that communication

can be initiated by a mobile phone through a dedicated Android application. The experiment was performed on the territory of Novi Sad (Serbia) first in open space by the river Danube, and then within the university campus which is an urban area with high buildings and green areas.

2 EQUIPMENT AND RSSI MEASUREMENT

The goal of deploying an alternative communication network is to provide an additional network that would allow basic mobile communication of the population in case of failure of the complete infrastructure of the commercial mobile operators during natural disasters or catastrophic events. Based on previous research [3], the idea of using LPWAN IoT RF communication modules was found to be justified, that enable longer range with low consumption in standby mode. The chosen nodes for this network are *Yatto Ltd.* [4] operating at a frequency of 868-870 MHz (*Fig. 1*). This module is based on the *Texas Instruments* CC1200 Radio Chip which allows the use of 3 data transfer rates at: 0.5 kb/s, 150 kb/s and 1 Mb/s. The operating frequency is set to 868.2 MHz. The module is designed for applications in IoT, Smart Cities, Industry 4.0, power plants, public safety, healthcare, and other applications that require wireless communication. The module uses a built-in narrowband ceramic antenna type 0868AT43A0020, by *Johanson Technology Inc.* [5] with which, according to the manufacturer's specifications, it can have a range up to 15 km in rural areas [4].

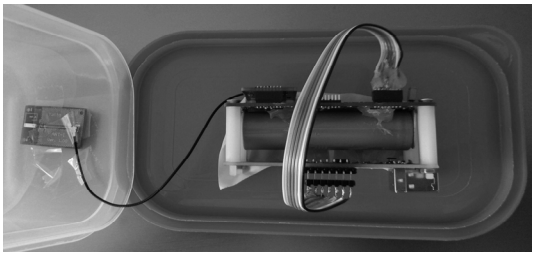

Fig. 1. LPWAN node with Chip antenna and USB connection for the PC

2.1 Connecting the node with the mobile phone, tablet or PC

The chosen RF module can communicate through SPI (*Serial Peripheral Interface*), I^2C (*Inter-Integrated Circuit*) or UART (*Universal asynchronous receiver-transmitter*) interface. For the purpose of testing, these communication interfaces were used through the BT (*Bluetooth*) connection (*Fig. 2*) and USB (*Universal Serial Bus*) connection (*Fig. 3*).

In order to provide comfortable and simple communication between the mobile control device, such as the mobile phone or tablet, the communication with the RF module was realized through HC-05 BT module [6] (*Fig. 2*). The BT module is configured in the Bridge communication regime where it enables BT ↔ UART communication.

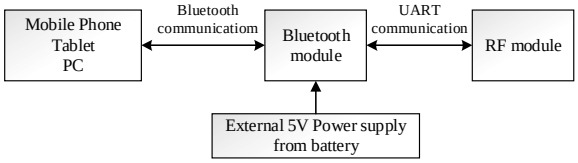

Fig. 2. Connection diagram between the RF module and the mobile phone

In order to provide higher autonomy of the whole system during testing, the BT module was powered by an additional 5V battery, instead of the power supply of the RF module. The RF module is powered by its own battery, so it does not require an additional power supply.

Fig. 3. Connection diagram between the RF module and the PC

Since modern computers, whether a desktop PC or a laptop, rarely have a RS232 serial interface ready to connect and communicate with other devices that use serial communication, in order to connect the RF module and the PC the widely used USB port was used for communication, through a USB ↔ UART converter realized with the FTDI232RL integrated circuit [7]. The USB ↔ UART converter is powered by the PC

power supply available on the USB port (5V with up to 2A). This power supply can also be easily connected and allow charging of the battery of the RF module through a simple LiPo (*Lithium polymer*) single cell charger.

2.2 Android application for measurement

For measuring the signal strength during the communication of the RF modules (nodes), a dedicated application was developed for Android 4.0+. *Fig. 4* presents the user interface of this application. The interface is designed and realized to be as user friendly as possible. The command buttons “SPEED 1”, “SPEED 2” and “SPEED 3” enable the user to choose the communication speed between the nodes (the possible options are: 0.5 kb/s, 150 kb/s, 1 Mb/s [4]). The radio buttons “Speed 1”, “Speed 2” and “Speed 3” display the selected communication speed. The command buttons “NODE 1 COORD.” and “NODE 2 COORD.” allow the input of the current GPS coordinates to two fixed nodes NODE 1 and NODE 2 respectively, which are placed on fixed positions with a goal to cover a certain territory with RF signal and communicate with the mobile nodes. When inputting the current GPS coordinates for a fixed node, it is required that the mobile phone be next to the node, since the GPS coordinates are taken from the GPS receiver in the phone. The checkbox “Coord” enables or disables the option for changing the current GPS location of nodes. Since the position of the fixed node is changed only when moving the fixed node to a new location, this option should be enabled only then, and disabled during the measurements. The command buttons “NODE 1 RSSI” and “NODE 2 RSSI” start the procedure for measuring the RSSI values of the signal between the nodes. After the measurement, the label “Time=” displays the elapsed time in seconds from the last sent command for measuring RSSI.

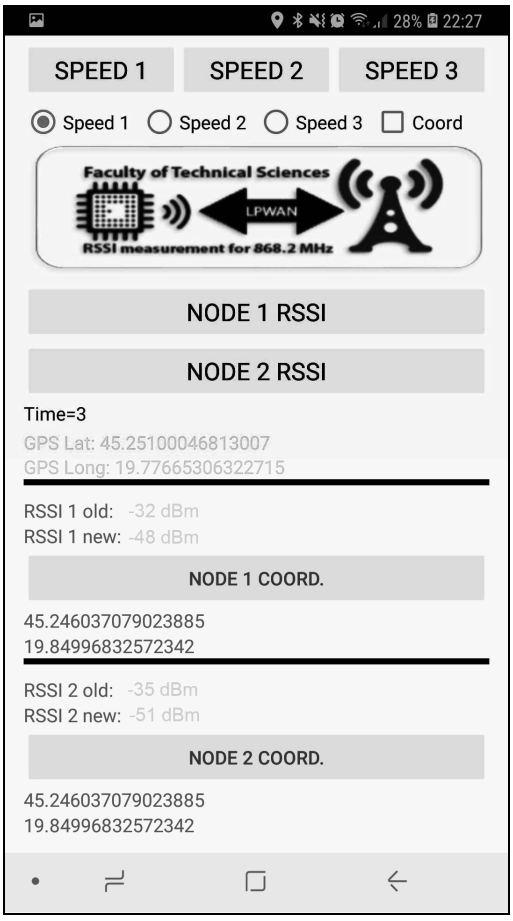

Fig. 4. Interface of the Android application for RSSI measurement

This information helps track the time from the start of the communication, especially when measuring RSSI at slower communication speed, when the transmission can last up to 5-10 s. If the reply from the fixed node does not arrive in a certain time period, it can be concluded that there is no communication between the nodes, i.e. that the fixed node is out of range. ”GPS Lat” and “GPS Long” display the current GPS latitude and longitude of the mobile phone, i.e. the fixed node. The labels ”RSSI old” and ”RSSI new” display the old and new measured RSSI value for both “NODE 1” and “NODE 2”.

The measurement of the signal strength between the nodes is straightforward, as the RF modules are able to inform the control device whether the message arrived successfully at the receiving end or not. If the communication is successful between the RF modules, beside this information, the control device receives the information on the RSSI value between the communicating RF modules. An example of the string transmitted to the node and the received acknowledge string is shown in *Table 1*. The Command string is a byte array, where the first

two bytes define the string length, followed by one byte that defines the message type, then seven bytes representing the physical address of the receiving node, then two bytes defining the command itself and at the end an array of bytes with the transmitted data. In the example in *Table 1* the string length is 13 bytes (0x00 0x0D), the message type is 0x52, address of the receiving node is 0x00 0x00 0x00 0x00 0x00 0x00 0x03, the command is 0x00 0x04 and the transmitted data in this case is only one byte with the value 0xDD. A single byte message is enough for measuring the RSSI value and the value 0xDD is arbitrarily chosen. After receiving the message, the addressed node replies in the same format, where the Message itself is replaced with the RSSI value for this transmission. In the example in *Table 1* it is the byte 0xB2 in the Acknowledge string, which corresponds to -78 dBm.

When the application receives the Acknowledge string, it displays the current RSSI value in the label "RSSI new", while the previous value is displayed in the label "RSSI old". In order to visually help the measurement process, these labels turn red when transmitting the message for the specific node, and turn back to green when the value is successfully received, accompanied by a sound signal that confirms the successful end of the measurement. All the measured RSSI values are recorded on the mobile phone in a CSV file. The format of the CSV records is: node label NODE 1 or NODE 2, GPS lat and long coordinate of the fixed node, date and time of the measurement, current GPS lat and long coordinate of the mobile phone, i.e. the mobile node, and the measured RSSI value.

Table 1. Communication string structure

	Length [2]		Type [1]	Address [7]							Command[2]		Message [-]
Comm.	0x00	0x0D	0x52	0x00	0x00	0x00	0x00	0x00	0x00	0x03	0x00	0x04	0xDD
Acknow.	0x00	0x0D	0x52	0x00	0x00	0x00	0x00	0x00	0x00	0x03	0x00	0x04	0xB2

[] - length in bits

2.3 Measurement method and location

The goal of measuring the RSSI values for the RF modules is to determine their range, so that the final node configuration can be set in the realization of the network in order to fully cover a certain region. In order to get the results for different field configurations, two locations were selected:

1. MP1 – open space on the bank of Danube near the Kamenjar settlement, and
2. MP2 – urban part of the city within and surrounding the University campus.

The measurement locations are marked on the map in *Fig. 5*. The points MP1 and MP2 show the positions of the fixed nodes, and the colored region around them is the measurement area. The small circles show the positions where the communication was successful.

The first testing was performed on the location MP1 (*Fig. 5*). The GPS position of the fixed node is: 45.22969938, 19.80260845. The node is mounted on a tripod stand on the roof of a car on the height of 3 m above the ground (*Fig. 6 left*). In this location the measurements were performed on all communication speeds (0.5 kb/s, 150 kb/s and 1 Mb/s) for two antenna types. The first antenna is a a built-in narrowband ceramic antenna type 0868AT43A0020, by *Johanson Technology Inc*. [5], and the other is a 15 cm omnidirectional GSM antenna (*Fig. 6 right*) with amplification of 5-6 dB. After these measurements it was found that the communication is the most reliable when using the slowest communication speed of 0.5 kb/s, and that the range is slightly better when using the omnidirectional GSM antenna.

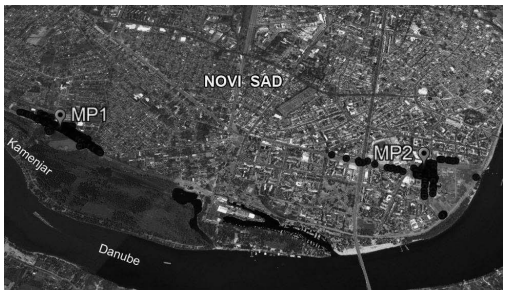

Fig. 5. Locations of the RSSI measurements

The second testing was performed on the location MP2 (*Fig. 5*). This is the location of the Assistants' dormitory, where two fixed nodes were set up on the 10th floor (highest in this building), on 33 m above ground. The first node is set up facing north-east toward the Petrovaradin fortress, and the other facing south-east toward city areas Liman I, II, and III. The GPS position of the first fixed node is: 45.246881, 19.848906, and the position of the second: 45.246671, 19.848898. For nodes on this location only measurements on the slowest speed (0.5 kb/s) with the GSM antenna were performed, since the previous measurements showed that this setup is the best.

Fig. 6. Fixed node MP1(left), GSM antenna (right)

During all measurements the mobile node used the built-in narrowband ceramic antenna type 0868AT43A0020, by *Johanson Technology Inc.* [5], and the position of the node was fixed on 1 m above ground. The measurements were performed in the end of July 2018. in dry and sunny weather with temperatures in the range of 32-35 °C, and relative humidity of 55-70%.

3 MEASUREMENT RESULTS

As described in the previous section, the measurements were performed on two locations. The first measurement was on the location MP1 out of urban area (*Fig. 5*), where the RSSI value was measured for each communication speed with the built-in antenna of the RF module, as well as with the omnidirectional antenna with the communication speed that provided the longest range.

The first two charts on *Fig. 7* show that for communication speeds of 150 kb/s and 1 Mb/s, the RF signal range is only 345-346 m. Also, they show that the RSSI value required for communication is -77 and -78 dBm. These communication speeds are fast enough, so the user has the impression that the sent data is received instantly (in less than 1 to 2 s). The longest range, 586 m, is achieved with the communication speed of 0.5 kb/s (third chart in *Fig. 7*), and in this case the required RSSI value for stable data transmission is only -95 dBm. In this case the data transmission takes 10 to 12 s.

As the slowest communication speed provided the longest range, the measurements were repeated with this speed, but with the omnidirectional GSM antenna, which transmits the signal evenly in all directions in space. As shown in the third chart of *Fig. 7* this antenna provided almost the same range as the built-in antenna, but when comparing the distribution of the points with successful measurements (*Fig. 8*), this antenna provides a more even distribution of points in the whole area, so this configuration was selected for further measurements.

The second part of testing involved measurements in location MP2 (*Fig. 5*) which is an urban area of Novi Sad with high buildings, cars and green areas (trees and hedges). In this part two fixed nodes were set up in a window of the Assistants' dorm in the university campus, on the 10th floor. In order to get better coverage, two nodes were set up: one facing north-east and one facing south-east. The first node (facing north-east) (fifth chart in *Fig. 7*) provided the range up to the river Danube (613 m), and the other one (facing south-east) (sixth chart in *Fig. 7*), had significantly longer range (a maximum of 1002 m), since there was optical visibility

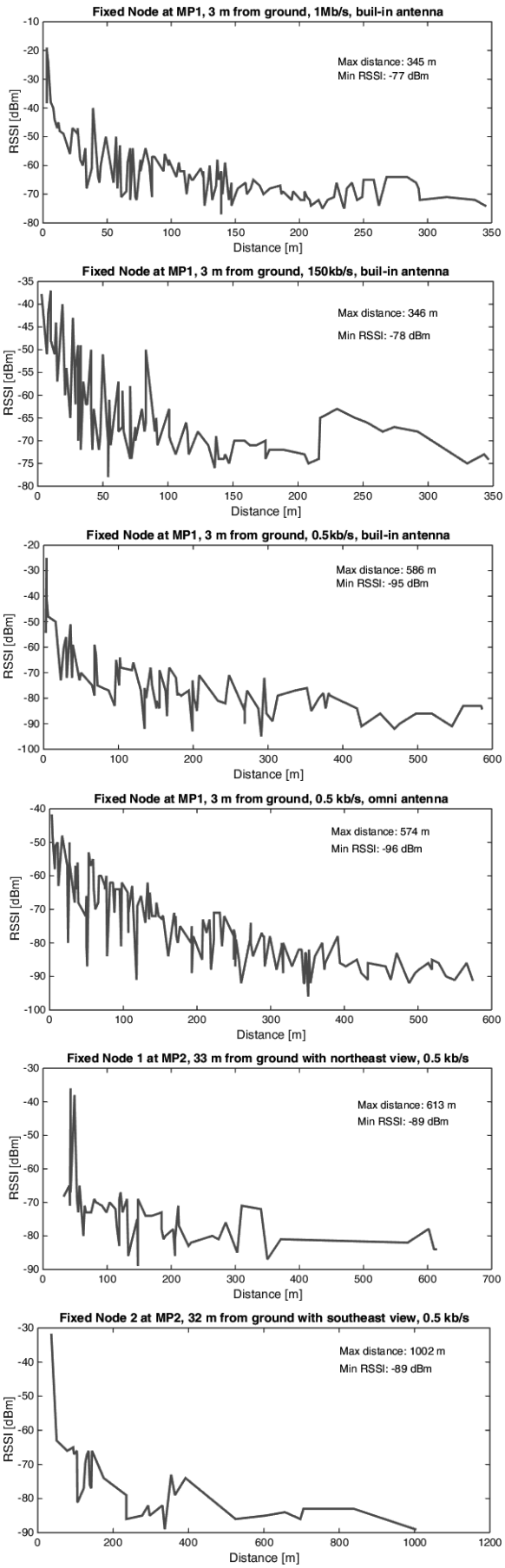

Fig. 7. RRSI measurements at MP1 and MP2

along a major boulevard. The communication required the signal to be 10 dBm stronger compared to the open space, which is probably the consequence of higher interference of radio waves due to high buildings. In all cases, almost absolute visibility was required for communication between the fixed node and the mobile node. In the areas where the view of the dorm was blocked, the communication could not be achieved

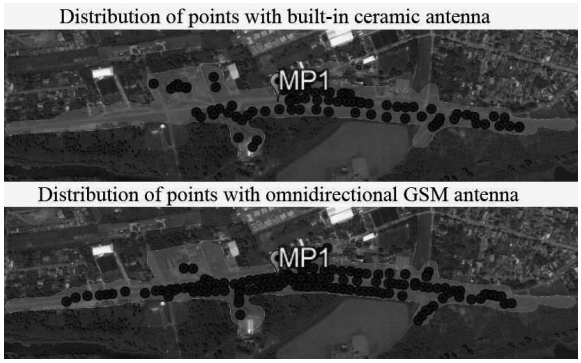

Fig. 8. Distribution of points with successful measurements

4 CONCLUSIONS

The measurement results presented in this paper show that when measuring the communication range of the selected LPWAN IoT RF modules, based on *Texas Instruments* CC1200 integral circuit, the longest range can be obtained when using the slowest communication speed. Since the planned alternative communication network is intended for use in emergency situations and disasters, when there is no other way of communication, this speed is adequate for the intended purpose, because the main goal is to transfer the message to the receiver, while the time is not critical on the level of seconds.

This paper presents the measurements in a peer-to-peer configuration, while in the real network each node can be a repeater, which could extremely extend the communication range, provided that each node has optical visibility with another node. The tested antennas have relatively low amplification, while the final realization can use stronger omnidirectional

antennas with higher amplification, and that way increase the range. The measurements showed that the RF module can communicate even with RSSI values of -96 dBm in the open space and -89 dBm in the urban area.

Further work on this project will be focused on deploying a test network with several nodes which are interconnected, as well as the required software for mobile phones and PCs for providing adequate communication over this network.

5. ACKNOWLEDGEMENTS

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Product Development in the Case of Device for Plate Rotation

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Abstract

This paper describe design of the conceptual solution of the device for plate rotation to facilitate and accelerate the preparation time for production of plates by using a manual or electric drive and thereby increase production productivity. The heating plates are use on a tire curing presses for different vehicle types. During plate machining, it is necessary to rotate the plate, which takes a lot of time, therefore we designed three different conceptual solution of device for rotating the plate. Conceptual solutions are design, made 3D models and basic dimensioning and payload calculations are made.

Keywords: Design, Development, Plate, Rotation

1. INTRODUCTION

The course design theory is taught in the fifth semester of professional undergraduate study program in production engineering on College of Slavonski Brod. The course design theory is divided into two parts, a theoretical and practical part. The theoretical part is 30 hours and covers basic concepts of the theory of the product, the product as a system, theory and technology of construction and process of mechanical design and techno-economic evaluation. The practical part is 30 hours, students are divided into groups and each group has a different project. Four or five students have the same goal but they must have a different conceptual design (different solution).

This paper presents a summary of student work. The goal of the work is design of the conceptual solution of the device for plate rotation to facilitate and accelerate the preparation time for production of plates by using a manual or electric drive and thereby increase production productivity. The heating plates are use on a tire curing presses for different vehicle types. During plate machining, it is necessary to rotate the plate, which takes a lot of time, therefore we designed three different conceptual solution of device for rotating the plate. Conceptual solutions are design, made 3D models and basic dimensioning and payload calculations are made. Three versions are made: A table version, Crane version (solid) and Crane version (loose).

2. DESIGN THEORY IN BRIEF

There are many approaches to explaining what it is design theory, there are many definitions that describe what design is, there are many elaborate methods of design that have a particular algorithm. Regardless of what design problem we are solving, we always, consciously or unconsciously, take some basic actions [1]:

- Establish the need or realize that there is a problem to solve.
- Plan how to solve the problem.
- Understand the problem by developing requirements and uncovering existing solutions for similar problems.
- Generate alternative solutions.
- Evaluate the alternatives by comparing them to the design requirements and to each other.
- Decide on acceptable solutions.
- Communicate the results.

We also divide the whole process on few steps [2]:

Goal (problem) explanation

Each group is thinking and talking about the topic of work, the idea for the product, this paper describes an exact problem at work.

System of information

The second step is to review the existing similar solutions, today the largest source of information is Internet and also printed catalogues, shops and general understanding of the environment and everyday life.

A list of requests and wishes

Planning task boils down to specifying all the information that can help solve the task. Students approach to creating a list of requests and wishes. The requests are the product features that must be met under all conditions, and without whose fulfilment solution is not acceptable. Wishes are product features that should be taken into account if they are justified.

Partial function

The overall function of the system should be divided into partial functions in a way that for each partial function if it is possible to find more than one solution (partial functions become partial tasks within the given task).

Structure function mechanical system includes [1]:

- General (overall) function of the system (the entire mechanical system)
- Partial function of the system (a set of machine elements)
- Elementary function of the system (one machine element)

Morphological table

The morphological table entries are possible solutions to certain partial function. Morphological table enables connection of individual solutions for partial functions on the principle of tolerance. Such a combination allows getting more variants to solve a problem. Each student in the group chooses its own solution or a variant.

Sketching

For variants that our preliminary analysis shows prospects of success, students made rough sketches of individual solutions in the rough scale. Based on the list of requirements, desires and morphological table approaches are being outlined and all sub-assemblies, detail, sizing ... during sketching students discover problems in their ideas and must be changed, corrected individual requirements, preferences, functions. "Optimization of conceptual solutions"

3D Modelling

After the adoption of the dimensions, material selection, rough calculation follows the creation of 3D models. After modelling the components approach the conclusion of sub-assemblies, subassemblies and hope the conclusion of the assembly to final assembly of the machine. After the positions are modelled, they are assembled in subassemblies and then the subassemblies are assembled in the product itself.

Calculation

The calculation may include sizing, check the type and amount of stress and comparison with the permissible (search critical of the structure), calculating the required output energy sources etc., Calculation kinematic sizes such as speed, acceleration, radius of action and the like the calculation of characteristic parts and specific characteristics.

Evaluation

In order to choose the best solution should be carried out evaluation (assessment goodies) using some of a valuation methodology commonly used techno-economic evaluation. The basis for evaluating solutions is a list of requirements.

3. DESIGN OF DEVICE FOR PLATE ROTATION

3.1. General information

The goal of the work is design of the device for plate rotation. For the system of information we have used examples from various manufacturing activities, for example cranes in production plants, manipulators in warehouses, tightening methods from mechanical engineering, etc. In the table 1. we can see a list of requests and wishes. In the table 2. we can see a Morphological table with partial functions.

Table 1. List of requests and wishes

requests or wishes	description
R	Use waste material
W	Easy handling
R	Minimal human effort
R	Sufficient loads
W	Mobility
R	Save time in production
R	Adjust the diameter for capture
W	Reduce the number of parts
Ž	Possibility of manual service
Z	Easy maintenance

Table 2. Morphological table

	PARTIAL FUNCTION	PRINCIPLE OF SOLUTIONS		
1.	dimensions of heating plates	Ø1100 mm	Ø1150 mm	Ø1200 mm
2.	material	metal	metal - plastic	metal - rubber
3.	shape of device	combined	table version	hanging
4.	mechanism of rotation	electro motor	manual	hydraulic
5.	tightening mechanism	manual	pneumatic	hydraulic
6.	prevent slipping	metal clamping surface	plastic clamping surface	sipaks clamping surface
7.	mobility	crane	wheels	forklift
8.	speed of rotation	no tact	30 sec/360°	in tact
9.	position regulation	two positions	without	four positions
10.	corrosion protection	tenifer	basic colour	blue creasing

3.2. Table version

The first version is conceived as a table version. The heating plates are positioned by a crane on the work table, clamped by the jaw and turned by an electric motor. On figure 1. we can see a sketch of a table version, and on figure 2. we can see 3D model of table version.

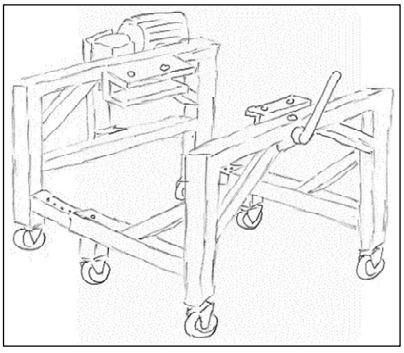

Fig. 1. Sketch of a table version

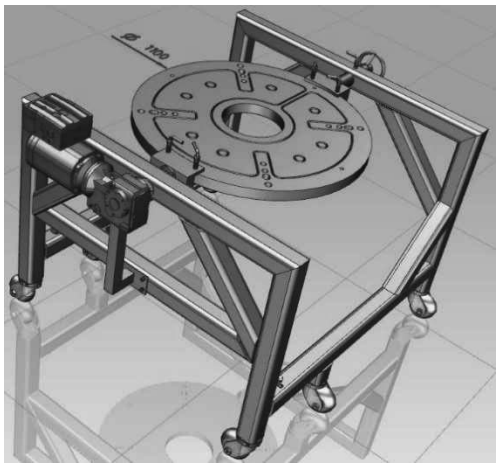

Fig. 2. 3D model of a table version

The following pictures show description and details of worktable version.

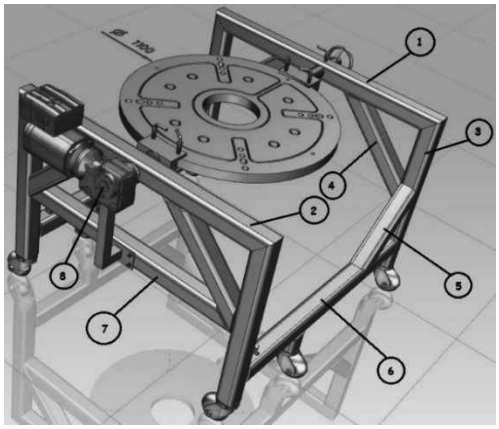

Fig. 3. 3D model of a worktable with positions

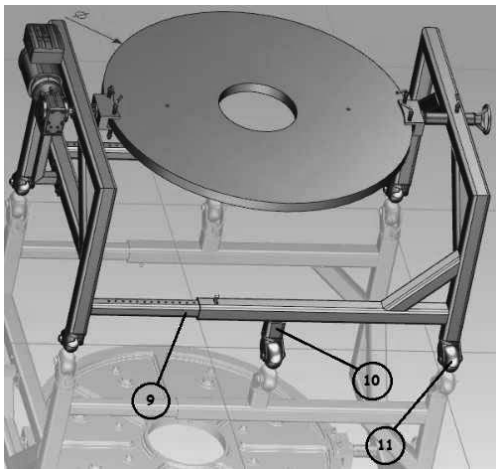

Fig. 4. 3D model of a table version with positions

Table 3. Name of the position of a table version

position	name	No. of pieces
1	tube 100x100	1
2	tube 100x100	1
3	tube 100x100	4
4	tube 100x100	4
5	tube 100x100	2
6	tube 100x100	2
7	tube 100x100	1
8	electromotor	1
9	tube 80x80	2
10	tube 100x100	2
11	wheel	6

On the next pictures we present some detail of table version.

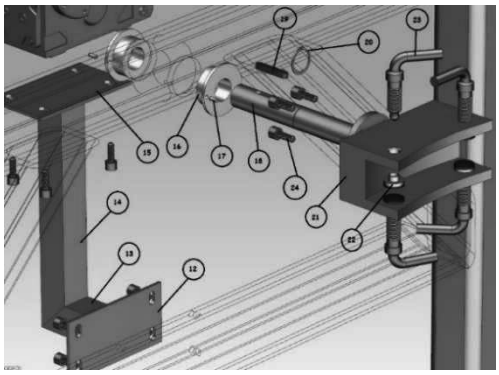

Fig. 5. Clamping devices with electromotor

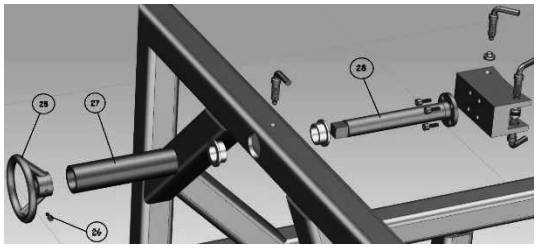

Fig. 6. Clamping devices with handle

Calculation

- Calculation of wheel load for worktable

Maximum dimensions of heating plates:
Dgp = 1200 mm = 1.2 m
dgp = 270 mm = 0.27 m
hgp = 50 mm = 0.05 m
Symbol explanation:
Dgp – Outside diameter of heating plates
dgp – Inside diameter of heating plates (diameter of hole for heating plates)
hgp – Thickness of heating plates

Calculation for mass of heating plates without hole (mass of roller)

$$m_{gpbp} = r_{gpv}^2 \cdot \pi \cdot h_{gp} \cdot \rho \qquad (1)$$

$$m_{gpbp} = 0.6^2 \cdot \pi \cdot 0.05 \cdot \rho = 43.90 \text{ kg} \approx 444 \text{ kg}$$

Symbol explanation:
r_{gpv} – Outside radius of heating plates
ρ – Average density of steel (kg/m$^{3)}$) [3]

Calculation of „mass of hole for heating plates“:

$$m_{pgp} = r_{gpu}^2 \cdot \pi \cdot h_{gp} \cdot \rho \qquad (2)$$

$$m_{pgp} = 0.135^2 \cdot \pi \cdot 0.05 \cdot 7850 = \text{„22.47 kg“} \approx \text{„22.5 kg“}$$

Symbol explanation:

r_{gpu} – Inside radius (radius of hole) heating plates

Mass of heating plates without holes:

$$m_{gpbš} = \left(r_{gpv}{}^2 \cdot \pi \cdot h_{gp} \cdot \rho \right) - \left(r_{gpu}{}^2 \cdot \pi \cdot h_{gp} \cdot \rho \right) \quad (3)$$

$$m_{gpbš} = 444 - 22.5 = 421.5 \text{ kg}$$

Heating plates are partly hollow because of space required for the steam, than for simplification in calculation, mass of 121.5 kg will be subtracted from total mass and final weight of heating plates will be 300 kg.

m_{gp} = 300 kg

Total weight for wheel load:

$$Q_{uk} = m_{gp} + m_{em} + m_{krs} \quad (4)$$

$$Q_{uk} = 300 + 28 + 368 = 696 \text{ kg}$$

Symbol explanation:

mem – Mass of electric motor on the workbench for heating plates

mkrs – Mass of steel construction for the workbench for heating plates

For simplification of calculation, assumption is made that all wheels are equally distributed. Workbench has six wheels, so the calculation for one wheel is displayed:

$$F_k = \frac{Q_{uk}}{6} \quad (5)$$

$$F_k = 116 \text{ kg} \cdot g = 116 \cdot 9.81 = 1137.96 \text{ N} \approx 1138 \text{ N}$$

Selected wheel is from the manufacturer Kama S3202 MMB 100 which displays max load of 150 kg, calculation satisfies. [4]

- Electric motor power calculation for load lifting

Calculation is simplified and the fact that electric motor and gearbox are lifting load. Required power of electric motor for lifting is selected based on the power required for lifting with equal speed.

$$P_{pot} = \frac{m_{gp} \cdot v_d}{\eta} \quad (6)$$

$$P_{pot} = \frac{300 \cdot 0.016}{0.95} \cdot 9.81 = 49.56 \text{ W}$$

Symbol explanation:

m_{gp} – Mass of heating plates
v_d – Lifting speed (m/s, (approximate value))
η – Efficiency of the gearbox, approximate value

3.3. Crane version (solid)

The second version is made as a version for the crane. It is conceived of a rigid construction that connects to an existing crane in operation. The heating plate is engageable with adjustable pods, raised with a crane, and the panel is rotating by hand or with the help of a handle.. On figure 7. we can see a sketch of a crane version, and on figure 8. we can see 3D model of crane version.

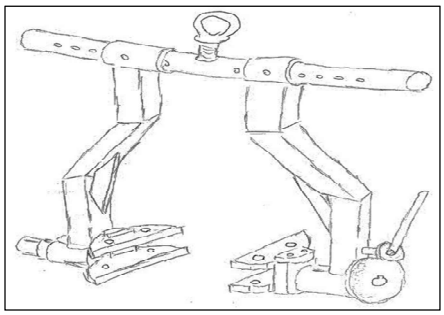

Fig. 7. Sketch of a crane version (rigid)

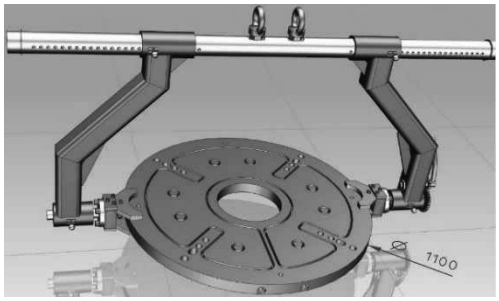

Fig. 8. 3D model of a crane version (rigid)

The following pictures show description and details of crane version (rigid).

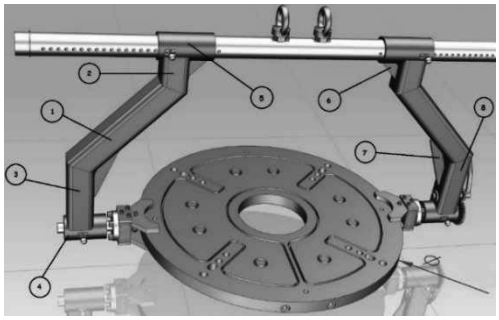

Fig. 9. 3D model of a crane version with positions

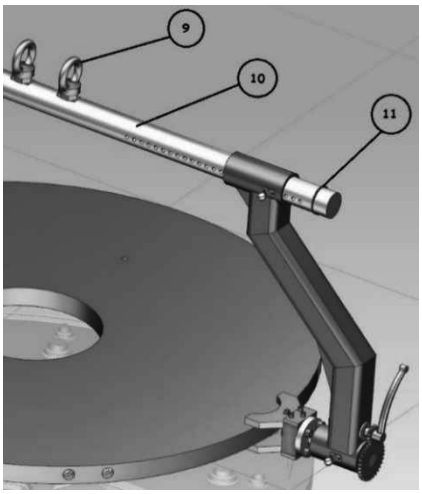

Fig. 10. 3D model of a crane version with positions

Table 4. Name of the position of a crane version

position	name	No. of pieces
1	tube 100x100	1
2	tube 100x100	1
3	tube 100x100	4
position	name	No. of pieces
4	Axle spindle housing	4
5	wiper	2
6	Supporting sheet	2
7	Supporting sheet	1
8	tube 100x100	1
9	hook	2
10	girder	2
11	slip ring	6

On the next pictures we present some detail of crane version.

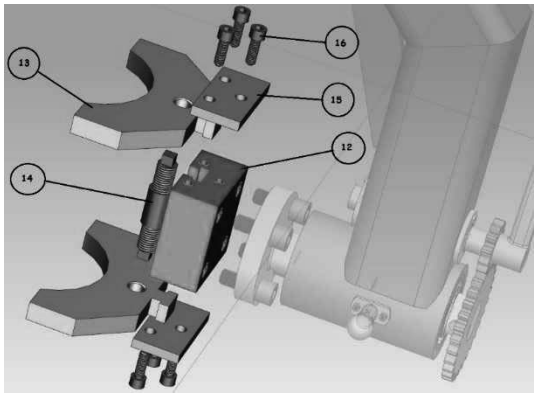

Fig. 11. clamping devices

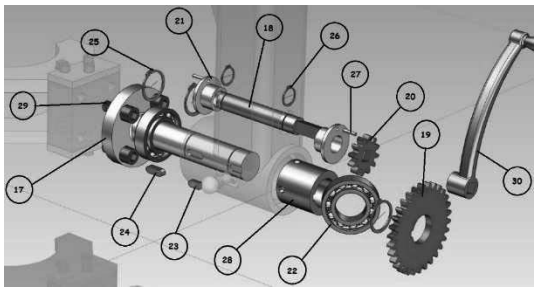

Fig. 12. handle with swing shaft

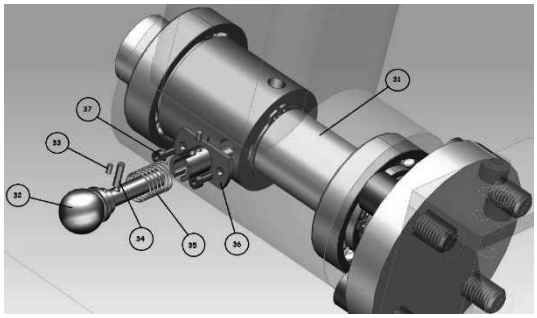

Fig. 13. Brake rods

Calculation

- Calculation of bearing rod full round cross section (shaft) for bending

For calculation simplification assumption is made. In the middle of shaft is placed one reactive force in one support. Also simplified is that on a distance of l/2 = 460 mm from support is on maximum force calculated with multiplication of mass of heating plate with gravity. Shaft mass is ignored.

$$F_{uk} = (m_{gp} + m_{vsc} + m_{sč}) \cdot g \qquad (7)$$

$$F_{uk} = (300 + 90 + 18) \cdot 9.81 = 4002.48\ \text{N} \approx 4003\ \text{N}$$

Symbol explanation:

F_{uk} – Total load for shaft
m_{gp} – Heating plate mass
m_{vsc} – Hanging tube assembly mass
$m_{sč}$ – Mass of the clamps

Maximum bending moment:

$$M_{smax} = F_{uk} \cdot \frac{l}{2} \qquad (8)$$

$$M_{smax} = 4003 \cdot 460 = 1841380\ \text{Nmm}$$

Axial resistance moment of cross section for full rod:

$$W_P = \frac{\pi \cdot d^3}{32} \quad (9)$$

$$W_P = \frac{\pi \cdot 80^3}{32} = 50265.482\ \text{mm}^3 \approx 50266\ \text{mm}^3$$

Allowed strain for bending:

$$\sigma_{sdop} = \frac{R_e}{S} \quad (10)$$

$$\sigma_{sdop} = \frac{250}{3} = 83.33\ \text{N/mm}^2$$

Material is construction steel S235JO with upper yield point R_e = 250 N/mm^2. [5]

Rod cross section dimensioning:

$$d \geq \sqrt[3]{\frac{32 \cdot M_{smax}}{\pi \cdot \sigma_{sdop}}} \quad (11)$$

$$d \geq \sqrt[3]{\frac{32 \cdot 1841380}{\pi \cdot 83.33}} = 60.829\ \text{mm}$$

Selection for shaft circular cross section is made to 80 mm so M20 thread can be made.

Bending strain:

$$\sigma_s = \frac{M_{smax}}{W_P} \quad (12)$$

$$\sigma_s = 36.64\ \text{Nmm}^2 \leq 83.64\ \text{Nmm}^2\ \sigma_{sdop}$$

Calculation satisfies.

3.3. Crane version (loose)

The third version conceived as a variant that tied to the crane. The heating plate is connected with the jaws that are connected to the crane over the steel rope. When the plate is raised rotation is done by means of a steel rope or by hand. On figure 14. we can see a sketch of a crane version (loose), and on figure 15. we can see 3D model of crane version (loose).

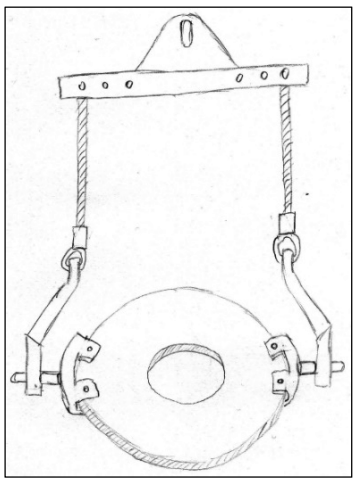

Fig. 14. Sketch of a crane version (loose)

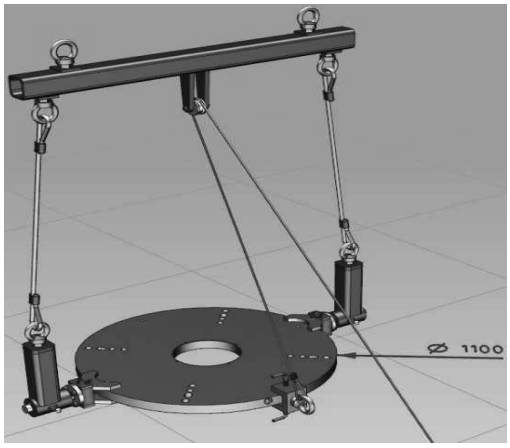

Fig. 15. 3D model of a crane version (loose)

The following pictures show description and details of crane version (loose).

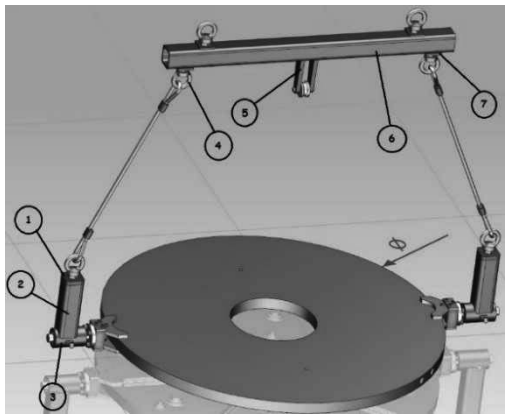

Fig. 16. 3D model of a crane version (loose)

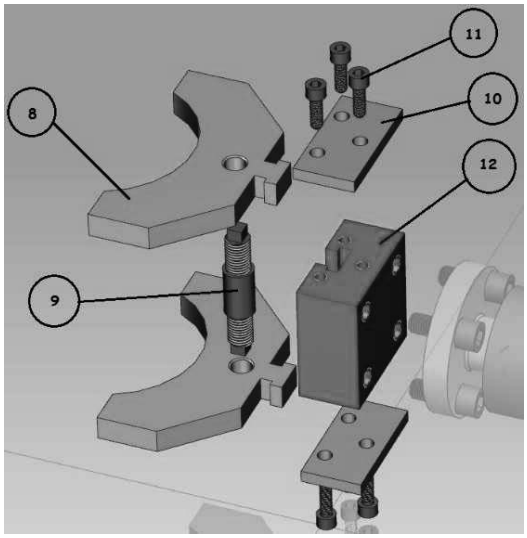

Fig. 17. 3D model of a crane version (loose)

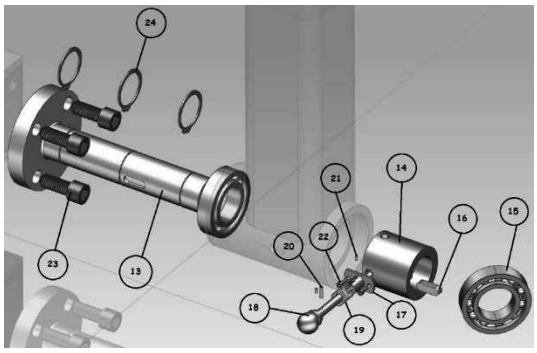

Fig. 18. 3D model of a crane version (loose)

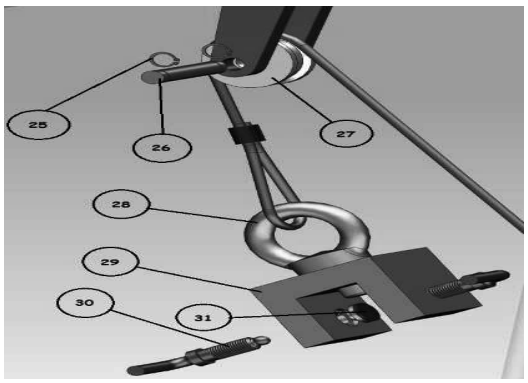

Fig. 19. 3D model of a crane version (loose)

Table 5. Name of the position of a crane version

position	name	No. of pieces
1	sheet metal	2
2	Bearing tube 100x100	2
3	Housing	2
4	Swinging hook	4
5	wheel support	2
6	Bearing tube	1
7	Bearing tube	4
8	Closing plate	4
9	thread M20	2
10	Protective sheet	4
11	Imbus screw M10	12
12	Housing	2
13	shaft	2
14	Brake hose	2
15	Bearing	4
16	Wedge	2
17	carrier	2
18	Brake pin	2
19	Spring	2
20	Distant pike	2
21	Coupling pin	4
22	Imbus screw M4	4
23	Imbus screw M16	8
24	Seger's ring	6
25	Seger's ring	2
26	Axle	1
27	pulley	1
28	Swinging hook	1
29	Clamping device	1
30	Clamp handle	1
31	Clamp cap	1

Calculation

- Bolt calculation for bending and required bolt dimensioning

Force on bolt:

$$F = m_{gp} \cdot g \qquad (13)$$

$$F = 300 \cdot 9.81 = 2943 \text{ N}$$

Max bending moment:

$$M_{smax} = \frac{F}{2} \cdot \left(\frac{l_2}{2} \cdot \frac{l_1}{4}\right) \qquad (14)$$

$$M_{smax} = \frac{2943}{2} \cdot \left(\frac{12}{2} + \frac{24}{2}\right) = 17658 \text{ Nmm}$$

Symbol explanation:
l1 – Length (mm)
l2 – Length (mm)

Bolt stress for bending:

$$\sigma_s = K_A \cdot \frac{M_{smax}}{W} \leq \sigma_{sdop} \qquad (15)$$

Symbol explanation:

KA – „Application factor depending on power train and work machine: Light stress 1,0...1,1; Medium stress 1,2...1,5; Hard stress 1,6...2,0; Very hard stress 2...3.“ [6]

σ_{sdop} – Allowed stress for bending according to material of bolt

$$\sigma_s = 1 \cdot \frac{17658}{215.68} = 81.87 \text{ N/mm}^2$$

Axial moment of resistance for full round cross section - rod:

$$W = \frac{d^3 \cdot \pi}{32} \qquad (16)$$

$$W = \frac{13^3 \cdot \pi}{32} = 215.68 \text{ mm}^3$$

Bolt diameter calculation:

$$d \leq \sqrt[3]{\frac{32 \cdot K_A \cdot M_{smax}}{\pi \cdot \sigma_{dop}}} \quad (17)$$

$$d \leq \sqrt[3]{\frac{32 \cdot 1 \cdot 17658}{\pi \cdot 125}} = 11.289 \text{ mm}$$

Selected bolt is loose smooth bolt made of material St 50-2 with allowed stress for bending of 125 N/mm^2 according to experience data. [7]

Diameter of bolt according to norm is d = 13 mm

$$\sigma_s = 81.87 \text{ N/mm}^2 \leq \sigma_{sdop} = 125 \text{ N/mm}^2$$

Calculation satisfies

4. CONCLUSIONS

This paper presents one of the ways of design a new product. The design process had these steps, goal, system of information, list of requests and wishes, partial functions, sketches, 3D model and calculations. There are three different variants of the device for turning plate. Because of a large number of positions, and a number of theoretical calculations can be made on the devices, and some of the most important are the power of the electric motors for turning the heating plates, the carrying capacity of screws and the like. We can conclude that all three variants should be further elaborated and taught deeply in model and calculations details so that the rotation device be fully functional and suitable for production process assistance. The variant number three is rated as the simplest and cheapest. Its main advantages are quick and easy handling, small number of positions and ease of making.

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Wear Debris Analysis of Gear Oil Used in Tunnel Boring Machine

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Abstract

Wear is the cause of failure in most of the cases such as lighter or heavier machine like tunnel boring machine. Wear is estimated by wear debris analysis by Ferrography. It is a remarkably helpful intends to decide the wear state of machines. Before endeavouring to extricate the element parameters of wear particles for distinguishing proof and investigation, it is important to isolated wear particles in ferrograph pictures. Henceforth, wear molecule division is a basic initial step for savvy ferrography in light of computer picture examination. Some exceptional wear particles, for example, ball, twisting chip, and bit were additionally got on testing machine. Ferrous, ferrous oxide, non-ferrous oxide and polymer were four type of wear particle found in used oil. Wear particle were scattered on the fixed area of ferrogram , image of wear particle were captured. Each wear particle has its significance or attributes on that basis they were categorised in different groups.

Keywords: wear debris, gear oil, ferrography

1. INTRODUCTION

The Wear takes place in minute gaps between interaction surfaces, measurement of wear debris is difficult in real time without changing interaction states of tribo-pairs. Concentration of wear debris increase due to large quantity of ferromagnetic debris occupied into gearbox [1]. Due to irregularities of sliding surface, a stick-slip oscillation detected in the profiles of friction caused by applied load. The increases in the surface irregularities and significant appearance of plastic deformation of the surface [2]. Surface area of component constantly erodes in online image of wear debris of chains, until the separation occurred accumulated areas continuously reduced in size. The advance specified condition for the termination, separated areas eroded until they vanished [3]. Explained about fault detection of spur gearbox system by two technique correlations, spur gearbox operates on constant condition of cyclic overloading. Techniques added new indication to diagnosis of the gear box system, which used to gearbox inspection [4]. One of the feature extraction and data reconstruction algorithms were developed for monitoring and reprocess the data of on line visual ferrograph to eliminate the inherited issues. The prediction of wear trend completed by traditional and relevance vector machine (RVM) model. There were two cases naturally occurred at the test duration oil change and abnormal wear which is used to evaluate the model performance in this study. Relevance vector machine has a greater accuracy of prediction in comparison with traditional model [5]. On the basis of wear performance and morphology of wear debris analyzed by

involved possible mechanism. Non- Euclidean entity described by the fractal geometry was applied to boundary texture qualitative analysis of wear debris, qualitative assessment was not enough effective to describe the morphology of wear debris on the basis of geometrical variation [6]. Under the lower loadings condition significant change were observed in the thermal behavior of wear debris formed during this condition. The possible relationships between structure and property and discussed the wear debris morphological feature and mode might have affected [7]. The characteristics of different tribological behavior revealed of the coating of the MoTiN and MoAlTiN against the sliding of different counterpart, demonstrate that on wide range of conditions difficult to achieve the accuracy of wear resistance and friction of coefficient low of Mo containing coated lubricous. More investigation and special protection were required for special application where coating applied [8]. For the tests of wear were obtained by rubbing action of a bearing metal in paraffin oil against carbon steel. The number and size could be measured in actual time in circulating oil. The calculated volume of each debris and, additionally, by accumulation of all debris volume of the total wear quantity was calculated during a given duration [9]. Developments progress in computable computer image analysis, used to identify the wear particle. Since there are many disciplines are applied in this technical area of 'infant-stage' for prediction and prevention of mechanical failure and the morphological analysis of wear particle through quantitative analysis of image [10]. The wear management may become more feasible with a greater understanding of the primary processes of resin composite wear [11].

2. EXPERIMENTAL STUDY

2.1. Rheometer

Rheometer used in this work is Rotonetic Drive. Rheology is a technique which is used to obtain the behavior of Newtonian and non-Newtonian fluids. It is used to obtain the relationships between, viscosity, temperature and strain rate. A small amount of sample loaded between two plates, or cup and bob system. A torque Applied to the top plate which exerts a rotational shear stress on the sample and the resulting strain (shear rate) is obtained. Rotational Rheometer and viscometers works on the same operating principle, but the Rheometer have greater functionality and accuracy.

2.2. Ferrography

Scientific ferrograhy initiates with attractive segment of wear debris and jetsam towards magnetic field [12]. The gear oil test is weekend for up gradation molecule precipitation and attachment. The oil flow downward on a glass slide called a ferrogram. The ferrogram stays on a magnetic barrel, which attracts ferrous particle out of the oil. Due to presence of magnetic field, ferrous particle make a chain like pattern and the biggest particle at the passage point. Non-ferrous and contaminated, unaffected by magnetic field, travel downward and are randomly settle down on the slide.

The ferrogram is analysed through bichromatic magnifying lens attached with computerized camera. The magnifying lens passes both reflected (top) and transmitted (base) light to recognise the shape, size, arrangements and condition of ferrous and non-ferrous particle. The particles are ordered to decide the sort of wear and repeat the experiments for getting higher accuracy.

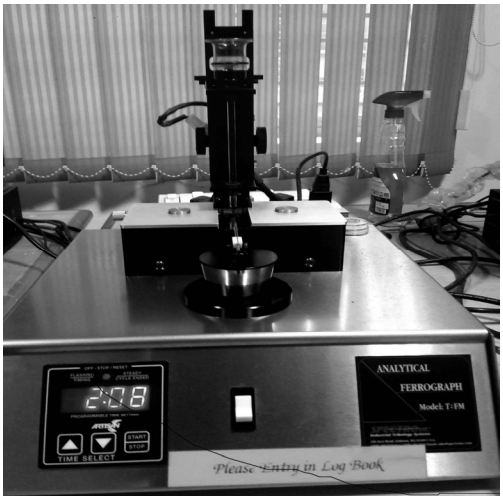

Fig. 1. Ferrogram maker for oil testing

2.3. Experimental setup for Ferrography

The glass testimony slide ferrrogram was of size in 60mm x 25mm x 0.17mm. The wear particles circulated along the section to the end long around 50 mm and width around 3 mm. Fig. 2 is a run of the mill picture of the ferrogram of the gear oil test from the test rotate gear in tunnel boring machine.

3. RESULTS AND ACHIEVEMENTS

3.1. Rheology investigation

In this paper we investigated that how viscosity changes with respect to temperature. It is clearly visible in (Fig 2.) that with the increase in temperature the viscosity of both the sample fresh and used lubricant was continuously decrease or degrade. Due to utilization of sample the viscosity is very low in comparison with the fresh lubricant. For the interpretation if density and nominal viscosity are used than the reported permeability of sample in a pressure-driven flow an effective property of transport has to be considered. That is the modification of permeability and viscosity [13]. In the process of enhance the estimation of these equations, modified mixing rules were used by use of alternative constants. Oxygenated mixture viscosities fount to be reasonable prediction by the modified equations. Also predicted the viscosity of biodiesel/ mixtures of oils by extensively used expressions [14] after the data analysis, a selection of experimental data was considered for the calculations for the change of surface tension and viscosity [15].

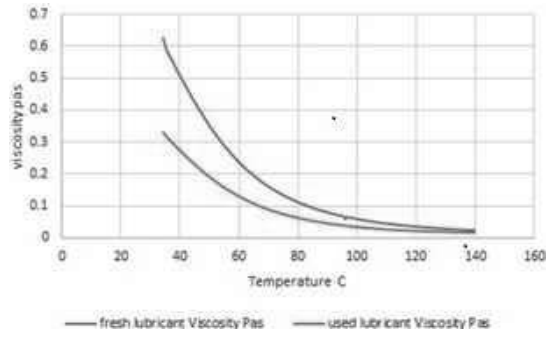

Fig. 2. Viscosity and temperature graph

There is a large inconsistency observed between results, nominal uncertainty eventually exceeds most of the obtainable literature measurements. The quest of a reference association for the sample viscosity requires the comprehension of independent measurements by using numerous rigorous investigational methods [16].

3.2. Ferrography investigation

The width of the wear molecule fastens fluctuated from 5 to 20 miniaturized scale meters. The diameter of the wear particles were around micrometres to many small scale meters. The particles estimate moved toward becoming littler with the developing statement remove from the section. On the account of ferrographic investigation the image taken from at normal temperature there is some impurities present in the lubricant due to that impurities debris particle not clearly visible, to remove the impurities and dust from ferrogram it was heated up to 100°C and impurities get removed in the form of vapours from the ferrogram. It is clearly visible that wear particles are in chain frame in Fig 3.

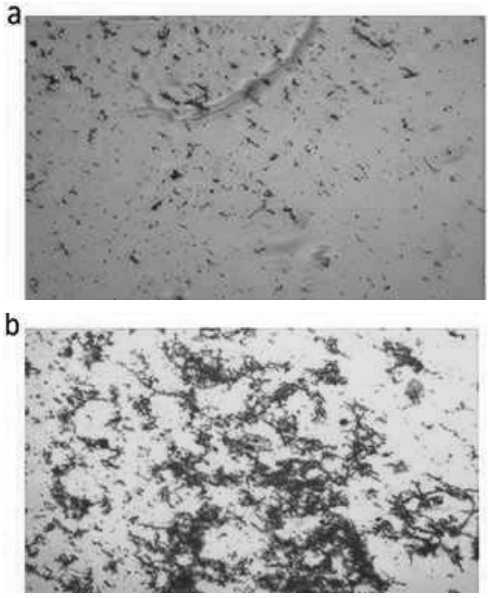

Fig. 3. Entry wear particle distribution on ferrogram with distance from entry as (a) 0 mm; (b) 10 mm

More ferrographic pictures demonstrated that the common wear molecule estimate were around 10 μm on slide. The wear molecule measure were 2– 3 μm at the area 10 mm.

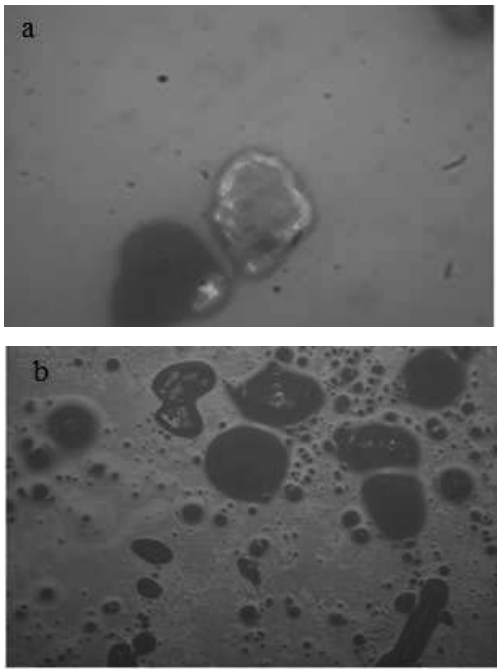

Fig. 4. After heating wear particle distribution on ferrogram with distance from entry as (a) 0 mm; (b) 10 mm

Some uncommon wear particles, for example, ball, twisting chip and fragment were set up after heating (Fig. 4). The hard Ferro ferric oxide molecule were squeezed and moved between the sliding turn and the bearing surfaces. The twisting and fragment cuts were peeled off the steel rotate shaft by hard particles or distensions of the gear surface.

4. CONCLUSIONS

The rheology test showed after running of lube or gear oil its viscosity was decreased. Viscosity was decrease due to wear debris and contaminants. Wear debris analysis was done with help of ferrogrpaphy. In ferrography experiment used gear oil are used for testing at different temperature. In this analysis, particles are distributed in different manner. Ferrous particles are distributed in chain form and non ferrous particle distributed randomly. Due to high wear of different machine parts, machines are unable to perform their task. With the help of ferrography it can easily find that which machine part is worn out more. Replace or refurbished the worn out part for continuous operation.

5. ACKNOWLEDGEMENTS

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Survey on Vehicular Ad-hoc Networks

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Abstract

Inter-vehicular communication (IVC) has become a reality driven by navigational safety requirements and by the investments of car manufacturers and public transport authorities. Thanks to the availability of radio communication equipment like radio interface, access points, spectrum, and standards, vehicular ad-hoc networks (VANETs) set the stage for unlimited opportunities for vehicle-to-vehicle applications. Navigation and road safety has now become an important priority for car manufacturers as well as municipal transportation authorities. Although research in the field of VANETs is relatively new, it is large and diverse. Indeed, consortia of researchers, car manufacturers and standards organizations are currently carrying out substantial research in order to propose standards for rapid deployment of the technology. This article covers the main ideas of VANETs and discusses their most important features followed by the presentation of the wireless communication standards in VANETs.

Keywords: vehicle engineering, VANET, IEEE 802.11p, ad-hoc, road safety

1. INTRODUCTION

Inter-Vehicle Communication (IVC) is attracting considerable attention from the research community and the automotive industry, where it is beneficial in providing Intelligent Transportation System (ITS) as well as assistant services for drivers and passengers. In this context, Vehicular Networks are emerging as a novel category of wireless networks, spontaneously formed between moving vehicles equipped with wireless interfaces that could have similar or different radio interface technologies, employing short-range to medium-range communication systems. The distinguished characteristics of vehicular networks such as high mobility, potentially large scale, and network partitioning introduce several challenges, which can greatly affect the future deployment of these networks.

In this survey, we present the most important features of VANETs including the available communication types, challenges, applications, main wireless communication norms and research directions in the field of VANETs.

2. VEHICULAR AD- HOC NETWORKS

Vehicular networks as shown in Figure 1. are a new emerging class of wireless networks. Vehicular Ad- hoc Networks (VANETs) are a subclass of Mobile Ad- hoc Networks (MANETs) where the nodes can be vehicles or fixed infrastructure called Road Side Units (RSUs) installed along the roads [1]. The various nodes of the network have equipment like computers, network interfaces and sensors that allow them to communicate via wireless

Fig. 1. Example of a VANET network [3]

technologies and to collect information concerning their environment and hence arises the name of smart vehicle [2].

3. COMMUNICATION IN VANETS

One can distinguish two main types of communication in VANETs: V2V Communication (Vehicle to Vehicle) and V2I Communication (Vehicle to Infrastructure) as described below.

3.1. Inter-Vehicle communication (V2V)

The purpose of car-to-car communication (Figure 2.) is to transmit information such as the road traffic on multiple hop to a group of receivers.

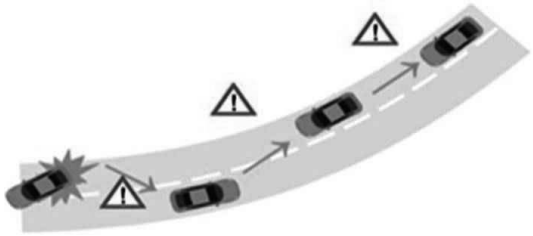

Fig. 2. Inter-Vehicle communication [4]

3.2. Vehicle to Infrastructure communication (V2I)

Road Side Units are located along the roads (Figure 3.); they serve as collectors, distributors and relays for various types of information, including emergency notifications. They may also accelerate the distribution of the information along the road using specific wireless channels established between them (Infrastructure to Infrastructure - I2I communication).

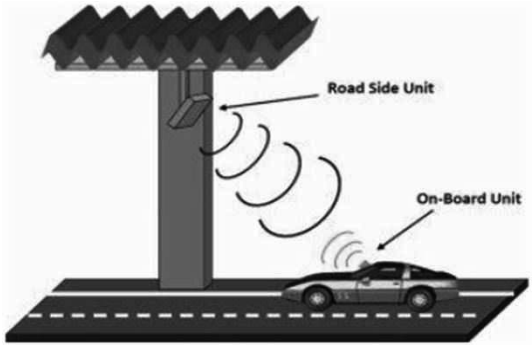

Fig. 3. Vehicle to Infrastructure communication

By combining these two types of communication, one obtains an interesting hybrid communication. The scopes of the infrastructure being limited, the use of vehicles like relay allows to extend the transmission range.

4. CHARACTERISTICS AND CHALLENGES OF VANETS

VANETs have the particularity to have a high mobility (the vehicles circulate at very high speeds), which gives an even more dynamic topology than in the case of MANETs. The mobile nodes are also restricted to move according to a road map, in the sense that, in general, a node cannot leave the road during his move. The realization of VANETs requires techniques and protocols that take into account the uncertainties and requirements of these networks. Vehicular networks arrive with following configurations.

HIGH TRANSMISSION RANGE

Theoretically, the communication range is 1 Km; in practice, it is around 200 meters [1]. The main advantage of the applied Dedicated short-range communication (DSRC) is the very low latency, below 100 milliseconds, which is ideal for security applications that require a delay in this range.

UNLIMITED CALCULATION POWER

The power of the vehicles is not a constraint as in the case of conventional ad hoc networks or

sensors, since the vehicle can provide the power required for calculation and transmission equipment, without having any energy or weight constraints as is the case of laptops, smartphones, tablets and other mobile equipment.

PREDICTABLE MOBILITY

Vehicles tend to have predictable movements, which are limited to the structure of the road. The Information about their mobility is provided by positioning systems such as GPS, card-based technologies or Dead Reckoning [6]. Given the average speed, the current speed and the road trajectory, the future position of a vehicle can be predicted. However, VANETs have to deal with certain characteristics that make difficult to design protocols capable of dealing with all these problems.

LARGE-SCALE NETWORK

Most ad hoc networks, usually assume a limited network size, vehicular networks can extend to large scale relatively to the entire road network and thus include many participants.

HIGH MOBILITY

The most important aspect of vehicles is their high mobility with speeds up to 200 km/h in the highway environment; this makes the network topology highly dynamic. Furthermore, the density of the nodes can be 1 to 2 vehicles per kilometre on a route with less traffic, meanwhile in urban areas speed cannot exceed 90 km/h with high traffic densities especially during peak hours, which makes the design of protocols sensitive and specific to each configuration.

PARTITIONED NETWORK

Due to their high mobility, the network is frequently divided. The dynamic nature of the traffic can generate a large inter-vehicle distance in sparsely populated cities, and consequently in several clusters of vehicles.

LIMITED BANDWIDTH

The nature of the radio link does not allow increasing the bandwidth infinitely; Vehicular

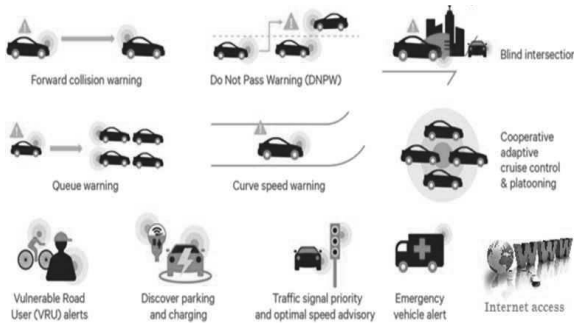

Fig. 4. Applications in VANETs

communication applications must consider this limitation.

NETWORK TOPOLOGY AND CONNECTIVITY

Network traffic scenarios are different from conventional ad hoc networks as vehicles move and change their positions constantly; the scenarios are highly dynamic. Therefore, the network topology changes frequently with the change of links in terms of connectivity. Indeed, the degree to which the network is connected is highly dependent on two factors: the range of wireless links and the fraction of participating vehicles.

5. VANET APPLICATIONS

Various VANET applications are emerging due to the development of new communication techniques that permit data collecting and sharing over the network. These applications are classified into three main areas: road safety and prevention, optimization of the traffic and passengers comfort. Road safety can significantly be increased by alerting the driver about dangerous situations and enlarging the driver's perception about the road traffic. Therefore the driver is warned about an eventual traffic jam, a rockslide or an accident before he approaches it, thus can avoid the road leading to it.

Vehicle networks are also improving the comfort of passengers; by offering services such as internet access as a result, they can download, send e-mails, view movies online, or participate in internet games. Dynamic "Gateways" are added to the network in order to provide

messages between the vehicles and the INTERNET. These applications use unicast routing as the primary communication method.

6. WIRELESS COMMUNICATION NORMS IN VANETS

Research in the field of VANETs is recent, but that does not prevent it from being a vast and diversified field of research and substantial research has emerged to design new standards for services and interfaces for vehicular networks. These standards form the basis for several applications. In what follows, we will clarify these few standards.

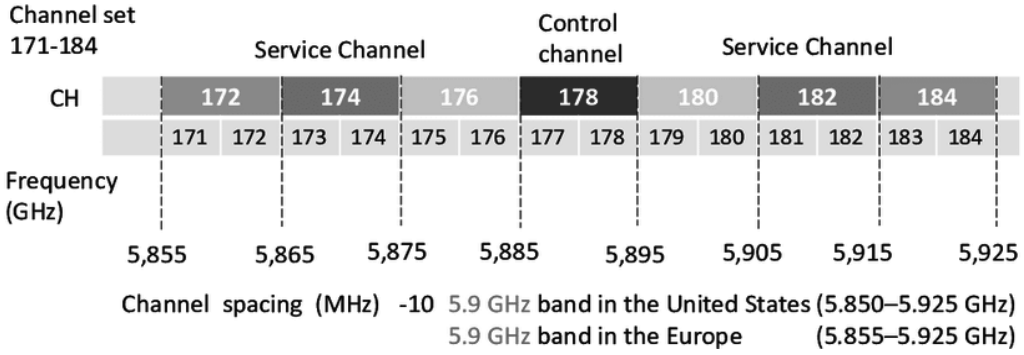

Fig. 5. DSRC frequency/channels repartition [7]

6.1. DSRC and 802.11P

In order to establish V2V communication within a group of vehicles, the American Society for Testing and Materials (ASTM) adopted in 2002 a wireless standard called DSRC (Dedicated Short Range Communication). In 2003, the IEEE working group resumed this work to define a new standard dedicated to inter-vehicle communications, called WAVE (Wireless Ability in Vehicular Environments) which includes the IEEE 802.11p standard. This standard use the multichannel concept to provide communication for security applications and other Intelligent Transport services and is based on the IEEE802.11e EDCA protocol for channel access control including priority mechanism.

DSRC TECHNOLOGY

DSRC is an emerging technology developed based on Wi-Fi standards. DSRC technology is used in the ITS domain to provide secure and reliable connections in both V2V and V2I communication.

These links allow the transfer of data that is necessary for the operations of different ITS applications. DSRC operates in the frequency band of 5.9 GHz (Europe and the United States) or 5.8 GHz (Japan).

The European Telecommunications Standards Institute (ETSI) and the Federal Communication Commission (FCC) define this frequency band in Europe and the United States respectively.

The frequency band is segmented into seven channels of 10 MHz each, the set of channels is functionally divided into one control channel and six service channels. The control channel is reserved for the transmission of network management flow and messages of high priority, like critical messages related to road safety. The other six channels are dedicated to the transmission of data from the various services announced on the control channel. DSRC brings together a series of standards and protocols dedicated to vehicular communications at the MAC and physical levels.

DSRC is designed to operate in dynamic networks to support the rapid establishment of links, minimize communication latency, ensure reliability of service for security applications taking into account the time constraints for this type of applications and support other non-security applications that require a Quality of

Service (QoS) guarantee. DSRC is developed for environments where short-term response (less than 50 milliseconds.) and/or high data rates are required in dynamic networks. The IEEE 1609 working group has standardized the rest of the DSRC protocol stack between the link layer and the application layer. Therefore IEEE 1609 is a standard for the high layers on which WAVE is based. The WAVE standards define an architecture and a complementary, standardized set of services and interfaces that collectively enable secure vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) wireless communications. Together these standards provide the foundation for a broad range of applications in the transportation environment, including vehicle safety, automated tolling, enhanced navigation, traffic management and many others.

THE IEEE 1609 FAMILY OF STANDARDS FOR THE WAVE

The family of IEEE 1609 standards for WAVE [8] defines the architecture, communications model, management structure, security mechanisms and physical access for high speed (up to 27 Mb/s) short range (up to 1000 m) low latency wireless communications in the vehicular environment. The primary architectural components defined by these standards are the On Board Unit (OBU), Road Side Unit (RSU), and WAVE interface.

THE 802.11P STANDARD

IEEE 802.11p is a custom variant of the IEEE 802.11a "PHY layer" that combines parts of the original standard with the 802.11e MAC amendment for QoS support.

Table 1. IEEE WAVE family standards description [7]

Wave Standard	usage	Description
IEEE 1609.1	Resource Manager	This standard defines the services and interfaces of the WAVE Resource Manager applications. It describes the message formats and the response to these messages. It also describes the data storage format that is used by applications to access other architectures.
IEEE 1609.2	Security Services	This standard defines the security, formatting, and secure processing of messages. It also defines how secure messages are exchanged.
IEEE 1609.3	Networking Services	This standard defines the routing and services of the transport layer. It also defines alternative messages specific to IPv6 that can be supported by applications. This standard also defines the Management Information Base (MIB) for the protocol stack.
IEEE 1609.4	Multi-Channel Operations	This standard defines the characteristics of the multi-channel in the DSRC. It is an amendment to the IEEE 802.11a Media Access Control Standard.
IEEE 1609.5	Communication Manager	This standard specifies communications management services for wireless access in vehicular environments (WAVE). This standard defines communication management services for wireless connectivity in vehicular environments between OBUs and RSUs
IEEE 1609.11	Over-the-Air Electronic Payment Data Exchange Protocol for ITS	This standard specifies the electronic payment service layer and payment and authentication profile for identity and payment data transfer in DSRC-based applications in wireless vehicular networks. This standard defines a basic level of technical interoperability (vehicle-infrastructure) for electronic payment equipment, namely on-board unit (OBU) and road unit (RSU) that use WAVE
IEEE P1609.12	Identifier Allocations	This standard specifies allocations of WAVE identifiers defined in the IEEE 1609 series of standards

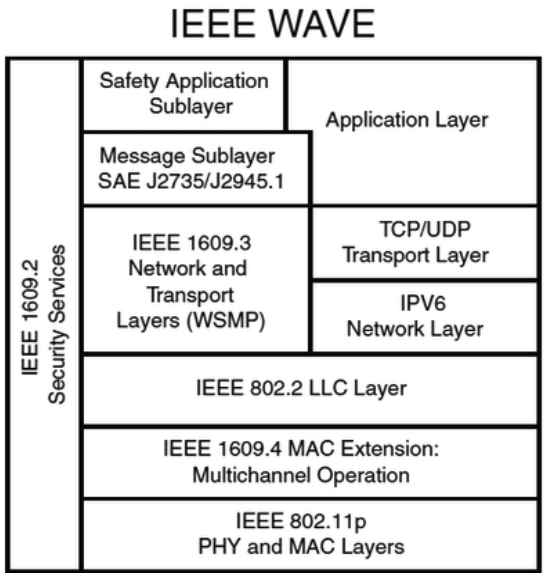

Fig. 6. WAVE protocol stack

6.2. Mac Layer

The IEEE 802.11p MAC Layer Extension is based on the IEEE 802.11e MAC Layer, which uses Enhanced Distributed Channel Access (EDCA) as an enhancement to the DCF protocol (IEEE802.11 CSMA / CA based access function). All stations perform this same algorithm in order to get access to the communication channel.

6.3. Physical Layer

This layer is derived from IEEE 802.11a. offers data exchange among vehicles (V2V) and between vehicles and roadside infrastructure (V2I) within a range of 1km) and a vehicle velocity up to 260 km/h [10] using a transmission rate of 3Mbps to 27Mbps with OFDM modulation (Orthogonal Frequency Division Multiplexing.

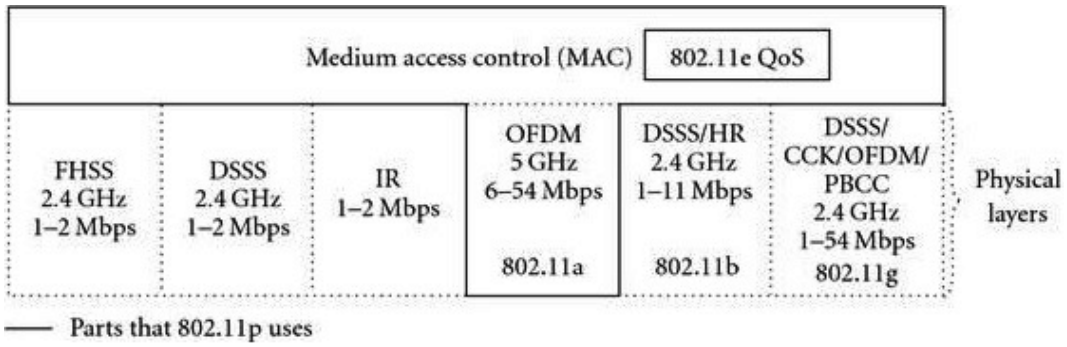

Fig. 7. IEEE 802.11p structure [11]

7. RESEARCH DIRECTIONS IN THE FIELD OF VANETS

VANETs are open to several areas of research, including safety, vehicle location, routing, and dissemination. Considering the sensitivity of the VANET applications, an intrusion of a malicious vehicle would have serious consequences for all the interconnected vehicles. Furthermore, if one of the vehicles in the network is to be located (in the case of an accident for example), the others must be informed about its position. The problem is that not all vehicles are equipped with a satellite tracking system (GPS); it is for this reason that a locating mechanism without using the GPS is necessary. In addition, one of the main feature of VANETs is that they quickly change topology because of their high mobility, which makes routing a very difficult problem to manage. In another hand, one of the problems of VANETs is that each vehicle communicates with all those in its coverage area, which can lead to several problems, like a deterioration in the quality of service (QoS) due to the increase in the number of vehicles, information redundancy, data loss (collisions), network congestion, or the B roadcast Storm problem.

8. CONCLUSIONS

VANETs is a promising wireless communication technology related field that could contribute to the improvement of road safety and information services in order to make driving more user-friendly and enjoyable. The deployment of this type of network on the road is one of the major concerns of the research and

industry community. In this article, the key ideas of VANETs and their communication types were presented alongside the most important standards dedicated for the communication over the network. Several research directions are worth to investigate in this field such as the dissemination of emergency messages over the network, routing, and security.

9. ACKNOWLEDGEMENTS

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BMW's Car-Sharing Services in China and Germany using Service Innovation

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Abstract

Today, demands in the automotive industry are at an all-time high with innovation playing a vital part. New concepts are shaped by creating significant structural changes in the business with environmental concerns playing a major role. This paper will provide insights into the opportunities and perspectives of BMW's processes to utilize service innovation for the development of pioneering business models such as car-sharing in the German and Chinese market. The obtained data analyses BMW Germany and BMW China standpoints on service innovation, and its practicality on the matter of car-sharing. Further, in a more detailed analysis, this research will demonstrate the differences of opinions about innovative means in the two countries showing specific alterations. Regarding BMW's car sharing model, its on-the-rise business indicates a lot of potential and room for the future; thus profound implications on the subject have been utilized in determining whether this may very well be the case.

Keywords: Service innovation, BMW, car-sharing, Germany, China

1. INTRODUCTION

The automotive industry is driven by innovative practices to improve current standards and to add value to their customers with the aim of gaining an advantage over competitors. The car culture has shaped how billions of people live making it a significant role in our daily life. Outcomes were an unprecedented number of motor vehicles used in the world that have led to a vast amount of problematic consequences such as traffic jams, the lack of parking spaces in urban areas as well as environmental pollution. Automobiles negatively affect the environment as it is the most significant contributor to pollution since the 18th century. Concepts such as car-sharing, artificial intelligence, autonomous driving, and electrification have been adopted and put into the spotlight to use innovative methods to tackle these problems. This research aims to establish whether service innovation is substantial for car sharing services in the German and Chinese market. It will analyze the future opportunities and threats using a theoretical framework which will complement the success of this business model in the global market over the long run. This will be carried out with the perspective on BMW's car sharing model by finding out their current and future strategies regarding the idea of generating innovation.

2. LITERATURE REVIEW

2.1. Innovation

There is no absolute definition of innovation, and it is more than likely that no one will ever come close to narrowing down any universal description accepted within and across the grounds. Nonetheless, well-known scientists of the past condensed the meaning of innovation allowing us to analyze the matter in a more detailed and structured way. According to

Michael Porter in 1996 innovation should not be confused for inventions as his studies were differentiating among product innovation and process innovation meaning doing things in a new way causing the product fundamentally to change and doing things differently leading to specific improvements to the current product, respectively (Porter, 1996).

Likewise, Joseph Schumpeter, who is considered to be one of the greatest economists on the field of innovation, believed that a pure entrepreneur plays a crucial role in driving economic development as its ideology creates new ideas and implements them, therefore contributing to the process of innovation considerably (Schumpeter, 1942). He assumed that an invention would ultimately become an innovation once it is placed on the market by an individual or business. More precisely he defined innovation as a "creative destruction" where new ways of technology would replace old obsolete ones (Schumpeter, 1942). The entrepreneur would eventually come up with a new idea, method or key offering a robust new approach to doing things that are more efficient and effective.

Ultimately, many factors encourage innovation to take place, if it is for competition or the proximity of the marketplace. Once innovative practices are exploited successfully this can cause the value of the economy and a particular product or service to increase, therefore enriching customer experience as well as profits earned by a business which is advantages for either party.

2.2. Service Innovation

There are four principal dimensions of service innovation which were analyzed by den Hertog (2000). First, the visual representation is presented, followed by the written explanation of each step as well as their inter-connectivity.

Once a new service is created its concept, and the new delivery scheme will be established resulting in the workforce to adapt to new ways of doing things, including customer relations while corporations will modify the course of IT

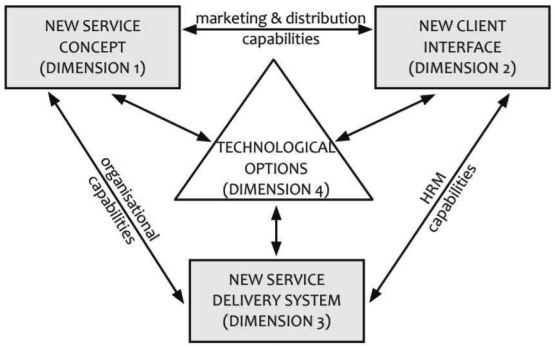

Fig. 1. 4 Dimensions of service innovation by Den Hertog

practices. Consider the case of the retail service sector. New cash registration platforms are provided throughout the retail store chain of a company which amounts to technological innovation (Dimension 4). These then have to be customized to follow the characteristics of the brand (Dimension 1) and to confirm a connection with customers (Dimension 2). Finally, employees also have to implement these changes to their tasks which can be done through training (Dimension 3).

2.3. Service Innovation in the automotive industry

There have been disruptions in the automobile industry over recent years in particular that have made traditional organisms redundant and have placed emphasis on new ecosystems wherein services are playing a pivotal role (Valente, 2017). Automobile corporations are more and more adopting to business models that relate to service innovation to enhance their capital and to add value to the company. An excellent example of a successful interpretation of service innovation in the car business dates back to Henry Ford who fundamentally changed the appearance of transportation. His accomplishment mainly resulted from the transformation of the then common business model which offered hand-made products to limited wealthy customers to a vehicle for Everyman at an affordable price. In other words, he adopted process innovative methods.

Nowadays, innovation is an essential factor to sustain a robust competitive position within

the auto industry. Product innovation, another sub-division of service innovation, is highly associated with automotive vehicles and can be represented in the form of, for example, new car design and the modification of manufacturing methods with industrial robots. Reasons like that are a crucial aspect of what car companies rely on to operate in the long run as through developments of their offered product, by using innovation, a new value is added to the customers who then go on to make the purchase.

The automotive industry is relying heavily on service innovation as it proves to give an advantageous edge over competitors if carried out successfully.

2.4. Germany's stance on service innovation

Laws are mainly about the manufacturing and the R&D side, but a justification for that would be that manufacturing innovation can be measured more easily than service innovation making it an essential challenge for improvements. Nonetheless, specific policies in Germany have been introduced to entrench service innovation in R&D and to provide better regulation in favor of service innovation. Furthermore, programs have been allocated by the government which is devoted to the research of innovation and concentrate about the development of customers and employees as well as the servitization of the industry (OECD, 2018). In other words, the goal is to attain additional value from services. The government of Germany is prioritizing innovation which has led, as of 2016, services to account to 68.9% to the total value added of economic activity (World Bank Group, 2016) diversifying the local economy from a dominant manufacturing standpoint.

The government of Germany is claiming that they are providing policies that favor innovation that will keep the edge of competitiveness of local firms remarkably high. Nonetheless, the government recognized that much has to be done to endorse the service sector in the future including several improvements to the current state due to the dominant nature of the German manufacturing division.

2.5. China's stance on service innovation

Chinese service innovation can be considered to be an interaction in manufacturing services and multi-participant networks. This can be interpreted as firms are tending to become more customer oriented rather than producer dominated with an outcome of great customization which is of fundamental importance in services.

Concerning policies, China's main weight is not on services and service innovation (Jing Hua Li, 2012). Strict and imbalanced regulations make it difficult for foreign firms to be part of an un-perfect market. Specific rules do the opposite then favor innovative practices in services with heavy tax burdens. Furthermore, a national non-governmental market union is none existing which may get in the way of professional services and their developments as well as service innovation protection and service research and development (Jing Hua Li, 2012). In other words, the development of service innovative practices differs from developing and developed countries and their economic conditions.

2.6. Car-sharing

Car sharing is similar to the structure of car rental where an individual can rent any given vehicle over a short period. It is intended for local users to help them in their daily community transportation and to benefit the environment as its goal is to decline car ownership and distance traveled. Furthermore, a fundamental concept of car sharing is to provide affordable and accessible vehicles for all communities while at the same time lessening fossil fuels emissions. (DriveNow, 2018)

2.7. BMW & DriveNow

BMW is a renowned German automotive brand which in 2011, implemented DriveNow which is their representation of car sharing. In Europe, DriveNow is currently available in 13

countries with around 1 million customers. In China, as of December 2017, it was launched in Chengdu after incorporation with the local firm EvCard and started with a small fleet of 100 BMW i3s. As of March of 2018 BMW and Daimler AG are planning to merge their car sharing operation and form a 50-50 joint venture to consolidate their market share and reduce risk in operating in an ever so rapidly changing tech-environment (Sachgau & Rauwald, 2018).

In practice, digital devices such as mobile phones are essential for the usage of car sharing applications as it provides a customer with the location of any vehicle the subscribed company is offering. True to its name, DriveNow offers cars within a city where they are located wherever and whenever it may be needed. At first, a potential customer has to sign up and register at the local BMW station where an electronic sticker will be placed upon ones driver's license which will turn it into a car key. The DriveNow app offers a variety of functions one of them being the location of all provided cars near you. Once a vehicle has been chosen the doors can be opened with the driver's license including a pin that will be sent to an individual via the app. This will allow the customer to drive the car at a price that is built by the minute, also including fuel expense. (BMW Group, 2017).

3. RESEARCH METHODOLOGY

The research was conducted using a qualitative and quantitative approach to get all the information. It is based on primary and secondary data research which were conducted with the BMW side in Germany and China and other professionals. The information gathered provides a descriptive and clarifying summary of the findings. Secondary research was also conducted from books, reports, journals, and websites and are used to give more background knowledge.

The in-dept interviews with BMW employees both in Germany and China as well as the survey together provide proper data allowing new ideas and a better understanding of the chosen topic.

4. FINDINGS & ANALYSIS

The survey data confirmed the profoundly embedded culture that BMW has with service innovation and sees it as an excellent opportunity to evolve further. Thereupon, BMW can be described as a company using service innovation as a strategic adaptation based on Miles (2005). The assessment of the primary data confirms this perspective. The following figure shows the connection between the dimensions of service innovation and car sharing.

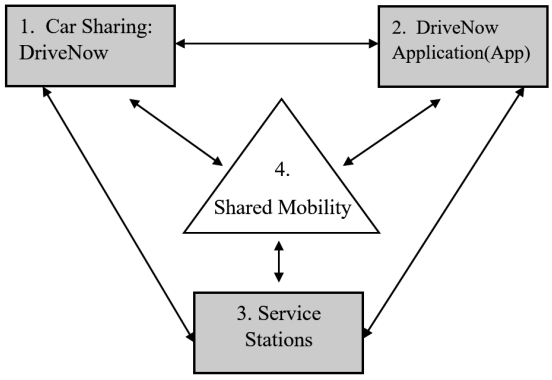

Fig. 2. Service innovation dimensions: car sharing

Referring to the research of den Hertog (2000) the car sharing concept employed my BMW called DriveNow can be associated with each step of the theory. Starting with Dimension 1, also called the service concept, it can be linked to the car sharing model such as DriveNow as it is a new business model applied by a firm. When it comes to dimension 2, the client interface, BMW does work closely with the customers to figure out what their wants and needs are. The application (App) is located on the user's phone, on which the business works on, and can detect customer's behavior as it gives a choice to writing reviews to deal with some issues. Moreover, it offers clients the opportunity to communicate with the staff of BMW to permit interactions to take place to improve the overall product. Dimension 3, the service delivery system, can be related to the

service stations BMW has around the globe where customers get started in signing up to use the car-sharing services. This involves BMW to train employees to be able to sell, advertise and understand the new product to be productive and efficient. Lastly, there is the fourth dimension, more specifically the technological options. IT is heavily relied on as car sharing processes are done over technological devices such as the cell phone, therefore enabling shared mobility to take place.

Therefore product innovation, a sub-division of service innovation, can be associated with car sharing as it is a modification of an already existing product that fulfills all the scopes of service innovation.

4.1. Discussion of the Findings

According to the survey results, Germany agreed that service innovation is a big influencer that drives the automotive industry, whereas China does not believe that to be the case showing a clash of opinions. Nonetheless, both countries have been showing similar trends into thinking that car sharing has potential not only in Germany but also in China and that service innovation has and will lead to substantial opportunities within that market space. In general, the mindset from the employees from China indicates China to be a more suitable market for car sharing as they believe they will get most out of innovative practices due to the highly competitive nature of the country. Additionally, more than the majority of the Chinese survey participants believe that the same does not apply to the German market. On the other hand, workers from Germany have faith and stated their confidence in the potential of the car-sharing business model to be roughly the same in both areas.

When it comes to the services sector, it was also addressed that China's economy is paying more attention to services and that there is an overall trend in that direction. This, however, got mixed results as German survey applicants disagreed with the statement of China moving away from a manufacturing industry while the Chinese enthusiastically stood for it. Both, on the other hand, approved Germany's economy to be service oriented. Another variance came about from the statement that people prefer to own rather than share a car with employees from Germany disagreeing and employees from China agreeing to show again that the Chinese market and its attitude towards car sharing has an abundant environment.

5. CONCLUSION

As it is presented throughout this paper service innovation provides substantial prospects for BMW to operate in and shows great potential for car sharing operations. The importance of service innovation is understood by BMW and therefore interpreted on a global scale, both in China and Germany. Both countries take the matter seriously, however, do interpret it differently as China focuses more on the customization part whereas Germany put their perspectives on the general substance of the theory.

In terms of car sharing, data shows that it will lead to fewer car ownership and fewer miles driven which will not only cause fewer cars to be used on roads solving congestion and traffic disputes but also will improve its environmental footprint. Furthermore, as the results suggest more people are willing to try car sharing services and with the affordable price tag it offers an optimistic approach to the realization of the new business model. In Germany, operations are continually expanding and it has reached the point where other strategies have been taking under considerations such as the consolidation of multiple brands into one entity. In this case scenario, it would on the one hand combine company's research on innovation and concepts which can be advantageous towards growing the business but on the other hand it results in less completion and therefore less innovative and competitive nature which may offset the need for productivity. In China, the market is

very modest; thus consolidation and keeping up productivity levels will lead to more market share and a competitive advantage giving the business an edge of being successful.

The collected data from the interviews and survey suggests a positive attitude towards innovation and its usefulness, and more precisely expresses that Germany does have more knowledge towards innovative processes used by BMW at the current marketplace. This indicates that Germany and China encourage service innovation and in more detail, BMW Germany and BMW China do fulfill all the step of the theory.

6. RECOMMENDATIONS

Along with service innovation "open service innovation should also be incorporated. It enables firms to get outside help from external parties to recognize service innovation as it leads to the inclusion of the public and outside opinions. This would allow BMW China to work closely together with their customers as they can now offer their input on several matters, and internationally, it would ensure for a greater product with more efficient and effective standards. Furthermore in order for employees to be most efficient when it comes to the usage of service innovation it is important to comprehend what it really stands for. Therefore, offering educational services such as workshops or seminars can help boost awareness so that BMW can get the most out of its employees. Subsequently, analyzing and tracking the signs of progress made would be constructive in determining progression. As technology is constantly advancing which is a large contributor to service innovation, it is my belief, that it is of utmost importance for the workforce to be regularly informed so that the most up-to-date procedures can be utilized.

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Welding of 2099-T83 Aluminium-Lithium Alloy by Electron Beam

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Abstract

The paper deals with the welding of AW 2099-T83 aluminium lithium alloy used in construction of lower wing stringers and aerospace applications. Electron beam welding with the accelerating voltage of 55 kV was used for welding. Welded joints were inspected by computer tomography, macroscopic and microscopic analysis, tensile strength test and microhardness measurement. Welded joints exhibited good weld joint formation, typical to electron beam welding. Weld metal was structure was dendritic formed by α solid solution. Decrease of microhardness was observed mainly in the centre of weld metal due to dissolution of precipitates. Further research will focus on post-heat treatment of welded joints in order to improve mechanical properties of weld metal.

Keywords: electron beam welding, AW 2099-T83, structural analysis, tensile strength, microhardness

1. INTRODUCTION

In comparison to other aluminium alloys, the Al-Li hardenable aluminium alloys offer higher elastic modulus, lower density, higher specific strength and higher tolerance to damage. The application of structural components made of Al-Li alloys plays a key-role in the aerospace industry in order to reduce the weight, increase the payload and improve the fuel efficiency of aircraft [1]. A possible solution to the problems with fusion weldability is the application of solid state welding methods, such as Friction Stir Welding (FSW) [2], but unfortunately this method can't be always implemented.

In order to minimize effect of fusion welding on final welded joint properties, the methods with low heat input, i.e. laser and electron-beam welding are preferred. The welded joints fabricated by the mentioned methods exhibit a very narrow HAZ and small deformations. Information on welding by concentrated energy sources is quite rare. The welding of 2196 and 2198 alloys by CO_2 laser received some world-wide publicity. The trend is the utilization of Al-Li alloy in the production of fillet welds, which are used to join the panels of the aircraft fuselage. In order to eliminate deterioration of the mechanical properties of weld joints during laser welding, it was necessary to ensure sufficient stirring [3]. Further data on laser welding concern the use of fibre laser for welding 2060 alloy with an Al-Mg-based filler material. Microhardness in the weld metal dropped to almost half the hardness of the parent material and tensile strength of the weld joint achieved approximately 63% [4]. The welding of Al-Li alloy 5A90 without filler metal by Nd:YAG laser received some publicity. Similarly documented was the decrease in mechanical properties due to reducing the amount of precipitates in the weld metal [5].

As for electron beam welding, only the analysis results regarding the welds fabricated of Al-Li alloy 8090 have been published. The alloy is considered as an experimental material. It is a precipitation-hardened alloy based of Al-Li-Cu-

Mg. Anisotropic structure strongly influences mechanical properties of the alloy 8090. Hot cracking in the weld metal occurs due to the formation of a eutectic mixture with low melting point. The observed decrease of mechanical properties of the weld metal was due to the welding temperature cycle [6]. The objective of this paper was to evaluate the possibilities of joining the 2099-T83 aluminium-lithium alloy by electron beam welding.

2. METHODS

The aluminium alloy used within the experiment was AW 2099-T83 with the thickness of 25.4 mm. Typical chemical composition of this alloy is provided in Table 1.

Table 1 Typical chemical composition of AW 2099-T83 alloy

Element	Weight %	Element	Weight %
Cu	2,4-3,0	Ti	0,10 max
Li	1,6-2,0	Fe	0,07 max
Zn	0,4-1,0	Si	0,05 max
Mg	0,10-0,50	Be	0,0001 max
Mn	0,10-0,50	Other	0,15 max
Zr	0,05-0,12	Al	bal

Typical mechanical properties of the material provided by manufacturer are shown in Table 2.

Table 2 Typical mechanical properties of AW 2099-T83 alloy

Tensile strength Rm [MPa]	560
Yield strength $Rp_{0.2}$ [MPa]	510
Ductility A [%]	4

In order to keep heat input as low as possible and to provide minimum width of heat affected zone, the electron beam welding (EBW) was applied. The parameters of EBW machine are provided in Table 3. The EBW device used for the experiment is shown in Figure 1.

Table 3 Basic parameters of EBW machine

Max. output power [kW]	30
Operating pressure [Pa]	2.10^{-2}
Chamber volume [m^3]	5.6
Max. accelerating voltage [kV]	max. 60

Fig. 1. EBW machine

Within the experiment the welded joint microstructure was analysed using standard metallography procedure. Samples taken from welded joint were grinded and polished. Keller etchant (2 ml HF, 3 ml HCL, 5 ml HNO_3, and 190 ml H_2O) was used for etching. Subsequently the microstructure of the welded joint was analysed using optical microscope Neophot 32.

Tensile strength of welded joints was measured according to ISO 5178:2001 standard. Three pieces from each sample were used in order to obtain the average values of tensile strength.

Microhardness was analysed in base material, in the weld metal adjacent to the weld surface, as well as in the centre and in the root section of welded joint. Moreover, the microhardness was also analysed in line starting from welded joint axis towards the base metal.

3. EXPERIMENT

The samples were welded in flat position according to ISO 6947. The canon distance from sample surface was 200±5 mm. Samples were cleaned from grease after the cutting process. Welding parameters are provided in Table 4.

Table 4 Welding parameters

Sample	1	2	3
Accelerating Voltage [kV]	55	55	55
Focusing Current [mA]	646	646	646
Welding current [mA]	117	117	117
Welding Speed [mm/s]	15	20	25

Figure 2 shows the weld surface appearance. The full penetration was observed in all welded joints. No significant spatter was observed. Sample No.1 exhibited irregularities in width of welded joint surface and the biggest weld root reinforcement. The weld width of other two samples was regular. All samples exhibited reinforcement of weld root. Sample No. 3 exhibited also the reinforcement of the welded joint surface.

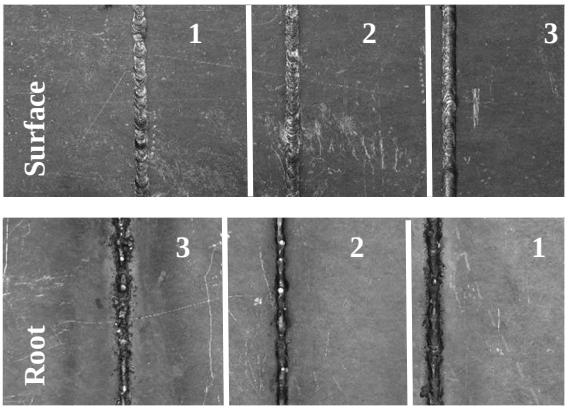

Fig. 2. Welded joints appearance: 1 – Sample No.1, 2 – Sample No.2, 3 – Sample No.3

Figure 3 documents the macroscopic analysis results. The macroscopy analysis revealed the porosity in all welded joints. The weld width was very narrow in all samples, as expected for electron beam welding.

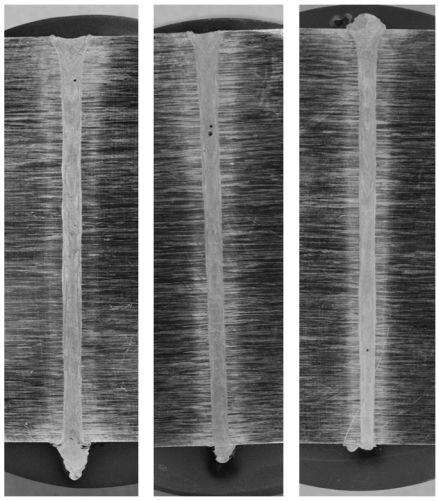

Fig. 3. Cross sections of welded joints: 1 – Sample No.1, 2 – Sample No.2, 3 – Sample No.3

The maximum size of the observed pore was 283 µm. The lowest porosity was observed in sample No. 3.

The microscopic analysis of base metal shows deformed grains as a consequence of rolling (Figure 4). The black particles represents the precipitates, strengthening the alloy.

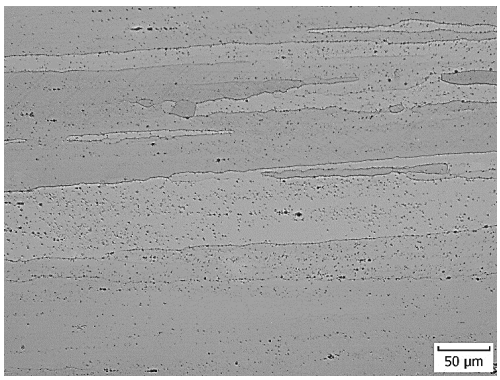

Fig. 4. Microstructure of AW 2099-T83 alloy

The microstructure of welded joints exhibited small difference in particular areas. Figure 5 documents the microstructure near the surface, in the middle and in the root section of the welded joint. Because of highest cooling rate in the middle of the weld metal the microstructure was formed by fine dendritic grains (with size about 10 µm). The biggest grains were observed near the weld surface as expected.

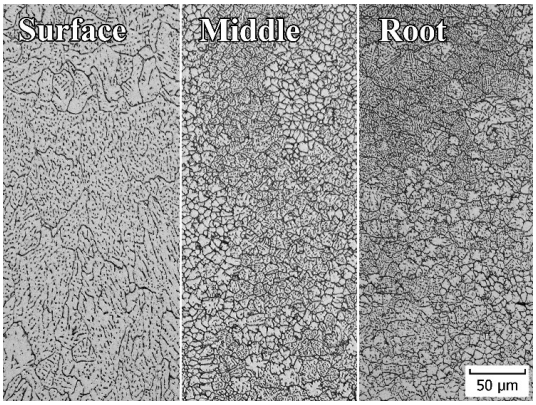

Fig. 5. Microstructure of weld metal

Figure 6 documents microstructure of the transition zone from weld metal (WM) to base material (BM). The heat affected zone is barely visible, however the microhardness measurement confirmed the presence of annealed area next to the weld metal.

The results of tensile strength test showed the average value of 366.43 MPa. The measured values were significantly lower in comparison to the base material. The tensile strength of welded

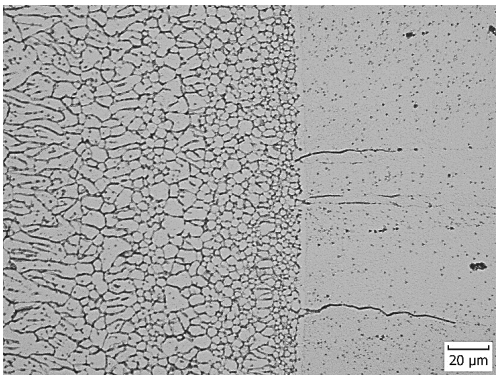

Fig. 6. Microstructure of transition area WM to BM

joint was only 65.43 % of strength declared by manufacturer (560 MPa). Main reasons for this significant decrease are the porosity in weld metal and annealing caused by welding process. Average microhardness value in weld metal was 79.65 HV0.1 and 173.1 HV0.1 in base material what represents the 53.98 % decrease. The microhardness differences in upper and lower sections of weld metal were insignificant. Reason of microhardness decrease was dissolution of precipitates in the weld metal caused by remelting of the base material. The results also showed that the microhardness of the base material was affected up to 2.6 mm from welded joint axis (Figure 7).

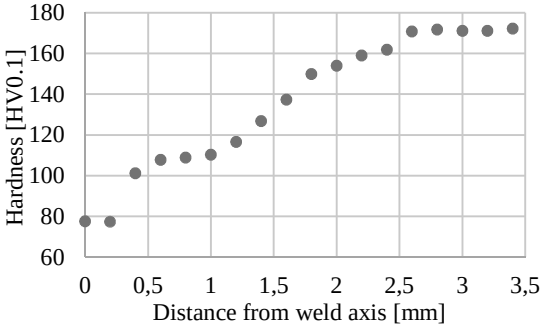

Fig. 7. Results of microhardness measurement

4. CONCLUSION

The results regarding weldability of AW 2099-T83 aluminium lithium alloy by electron beam welding are promising. Weld metal exhibited dendritic structure having grain size in range from 10 µm to 80 µm in dependence on its position. As expected, originally hardened base material was annealed in weld metal as well as in distance from weld metal axis up to 2.6 mm. The annealing and porosity of welded joints caused the tensile strength drop to 65.43 %. Best results were achieved in sample No.3. This sample showed lowest porosity, no convexity in welded joint surface and smallest weld root reinforcement. Further research will be focused on more precise analysis of the porosity using computer tomography and heat treatment to improve the mechanical properties of welded joints.

5. ACKNOWLEDGEMENT

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Laser Welding of AW2099 Al-Li Alloy with Al-Mg Filler Metal

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Abstract

Newly developed AW2099 aluminium lithium alloy with the thickness of 2.0 mm was studied within the paper. Sound weld joints were produced under optimized welding parameters. Al-Mg 5087 filler wire with the diameter of 1.2 mm was used for welding AW2099 Al-Li alloy. Argon was used as a shielding gas. Weld metal microstructure and weld joints mechanical properties were investigated. Microstructure of weld metal consists of α-aluminium solid solution. Interdendritic areas were enriched in alloying elements. Narrow equiaxed zone was observed at the fusion boundary. This feature is characteristic for welds in aluminium lithium alloys. Microhardness drop in the weld metal was recorded. The optimized welding parameters are as follows: laser power 1.5 kW, welding speed 10 mm/s, focus position +1 mm and filler wire feed rate 1 m/min.

Keywords: aluminium lithium alloy, disk laser, laser beam welding, equiaxed zone, scanning electron microscopy, mechanical properties.

1. INTRODUCTION

The addition of lithium to the aluminium is beneficial from the weight reduction point of view. Addition of 1 % of Li causes the decrease in the aluminium alloy density by 3 % and increase of modulus of elasticity by 6 % [1-4]. The 3rd generation Al-Li alloys is characteristic by increased Cu/Li ratio and the addition of other minor alloying elements [5].

Zn additions improved corrosion resistance. The additions of Cu, Li and Mg form the strengthening precipitates and small additions of the dispersoid forming elements Zr and Mn control the grain structure and crystallographic texture during thermo-mechanical processing [6].In mentioned alloys more than one strengthening precipitate are precipitated and dissolved at various temperatures [7].

Al-Li 2099 alloy has low density, high stiffness, superior damage tolerance, excellent corrosion resistance and weldability for use in aerospace structures that require high strength. The 2099 plate and forgings have better strength, modulus, density and corrosion performance than 7075-T73 and 7050-T74 aluminium alloy plate products [6,8].

Arc welding processes characterized by high heat input result in the elimination of strengthening of the materials in HAZ and weld metal. Thermal cycle generated in welded material causes the dissolution of phases such as δ′ and T1 resulting in softening mentioned zones. From that point of view, laser beam welding is an attractive welding technique for Al-Li alloys because of very concentrated heat causing a formation of narrow weld joints with

narrow HAZ [9]. Furthermore, high welding speeds lead to formation of minimum deformations and residual stresses. Narrow HAZ means softening region of much smaller dimensions in comparison to arc welding processes.

Research focused on the weldability of Al-Li alloys is underway worldwide. A few papers focused on the welding of Al-Li alloys with the Al-Si filler wire. Han et al. performed double sided laser beam welding of 2 mm thick 2060-T8 and 2099-T83 Al-Li alloys with the use of 4047 filler wire. Authors observed that segregation in the weld was characterized by the formation of T (LiAlSi), θ (Al_2Cu) and eutectics at grain boundaries. Furthermore, the interfacial layer between T-phase and α-Al matrix was found to be composed of alternately crystallized θ-phases and Al-Si eutectics [10]. But information on laser welding of Al-Li alloys with Al-Mg based filler wire are still limited.

The aim of the study is to analyse the microstructure and mechanical properties of produced laser welds on AW2099 aluminium-lithium alloy.

2. METHODS AND MATERIALS USED FOR RESEARCH

AW2099-T83 aluminium lithium alloy was proposed as base material. Initial thickness of as delivered Al-Li alloy was 25.4 mm. AW2099 aluminium lithium alloy was reduced to the final thickness of 2 mm. Solution heat treatment at 530 °C followed by rapid quenching was carried out before cold rolling. The chemical composition provided by Smiths High Performance is given in Tab. 1.

Table 1. Chemical composition of AW2099 Al-Li alloy

Cu	Li	Zn	Mg	Mn	Zr
2.4-3.0	1.6-2.0	0.4-1.0	0.1-0.5	0.1-0.5	0.05-0.12
Ti	Fe	Si	Be	Al	
≤ 0.1	≤ 0.07	≤ 0.05	≤ 0.0001	Balance	

Al-Mg 5087 filler wire with the diameter of 1.2 mm was used for joining. Chemical composition of filler wire is given in Tab. 2.

Table 2. Chemical composition of 5087 filler wire

Si	Fe	Cu	Mg	Mn	Cr
≤ 0.25	≤ 0.40	≤ 0.05	4.5-5.2	0.7-1.1	0.05-0.25
Zn	Zr	Ti	Be	Al	
≤ 0.25	0.1-0.2	≤ 0.15	≤ 0.0003	Balance	

TruDisk 4002 disk laser with the wavelength of 1.03 μm, beam quality (BPP) 8 mm.mrad and maximum power of 2.0 kW was used for production of weld joints. Spot size of the focused laser beam was 400 μm. Argon with the flow rate of 18 l/min was used as shielding gas. The welding parameters are given in Table 3.

The weld joints were prepared by standard metallographic procedure. Keller's reagent was used to reveal the microstructure of the weld joints. The analysis of microstructure was carried out to understand the influence of different thermal cycles experienced during welding on the final microstructures in different zones of the weld joints.

Table 3. Parameters of welding AW2099 Al-Li alloy

Weld no.	Laser power [kW]	Welding speed [mm/s]	Focus position [mm]	Filler wire feed rate [m/min]
1	1.35	10	+1	1
2	1.4	10	+1	1
3	1.5	10	+1	1

JEOL JSM 7600 F scanning electron microscope was used to study the microstructure and chemical composition of weld joints in more detail. Microhardness measurements across base metal – HAZ – weld metal interface was carried out on Buehler IndentaMet 1100 microhardness tester. Loading force of 0.98 N applied for 10 s was used. Distance between indents was 500 μm.

3. RESULTS

The cross section of weld joint produced with the welding parameters: laser power of 1.5 kW, welding speed 10 mm/s and filler wire feed

rate of 1 m/min is given in Fig. 1. No defects like pores and hot cracking were observed in weld metal. The width of weld metal is 4.3 mm and the width of HAZ is 2.2 mm. No cross section thickness reduction was observed because of the use of 5087 filler material.

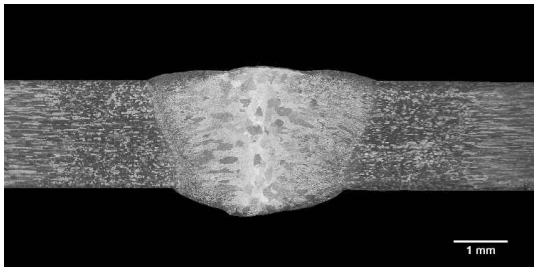

Fig. 1 Cross section of selected weld joint

Magnesium increases the solubility of hydrogen resulting in avoiding porosity formation being characteristic for welding of aluminium and its alloys. HAZ – weld metal interface is given in Fig. 2. Three zones from the grain morphology point of view were observed, i.e. equiaxed zone (EQZ), columnar dendrite zone (CDZ) and equiaxed dendrite zone (EDZ).

A narrow EQZ with the width of about 30 μm consisting of equiaxed grains of average size 12 μm was found between the fusion boundary and WM. The grain interiors are precipitate-free, while eutectic was observed at the grain boundaries [11].

Equiaxed grains were probably formed due to heterogeneous nucleation at the lithium and zirconium rich precipitates.

The higher temperatures acting towards the weld centre cause Al_3Zr precipitates dissolution and promote the growth of columnar grains [12].

Tao et al. studied fiber laser welding using eutectic alloy AA4047 filler wire. Authors found that solute segregations of Si and Cu occurred at the grain boundaries in the HAZ and WM. The nondendritic equiaxed zone was the minimum hardness and weakest region of the whole joint [13].

The zone of very fine dendrites was observed in the central part of weld joint (Fig. 3). It is worth underlining that Zr was present in the 5087 filler wire. Zirconium promoted grain

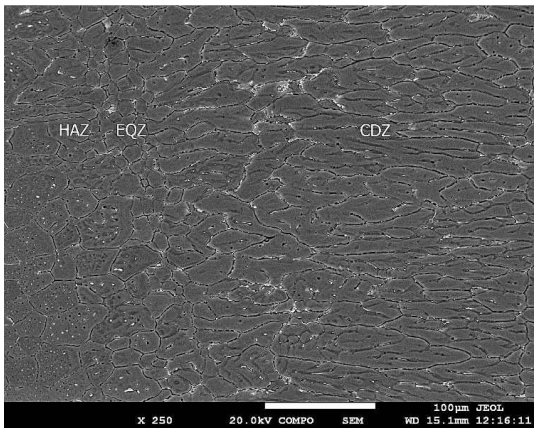

Fig. 2 HAZ – weld metal interface

refinement in that area. Equiaxed dendrite zone is given in Fig. 4.

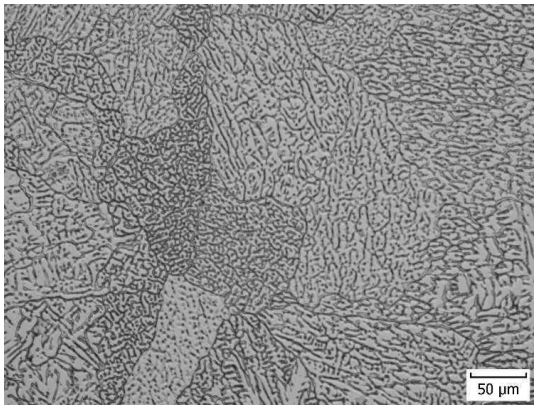

Fig. 3 Microstructure of central zone in weld metal

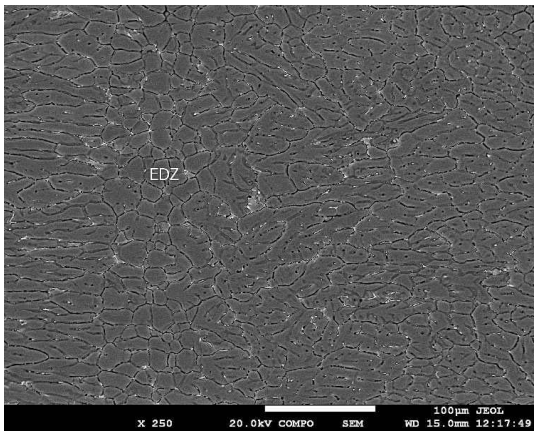

Fig. 4 Equiaxed dendrite zone in weld metal

The content of copper was higher in the bright particles than in aluminium solid solution matrix because of segregation process. Grain boundaries were enriched in copper. Copper EDX linescan across particle – aluminium matrix interface is given in Fig. 5. The drop of copper content towards aluminium solid solution was observed (Fig. 6). Contrary, red line

indicating the course of aluminium content revealed that aluminium content increased from bright particle towards solid solution.

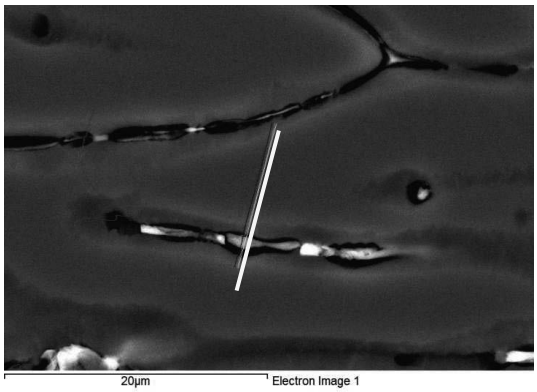

Fig. 5 Bright particle present in WM

Eutectics were observed at the grain boundaries of EQZ and weld metal caused by solute segregation due to non-equilibrium solidification.

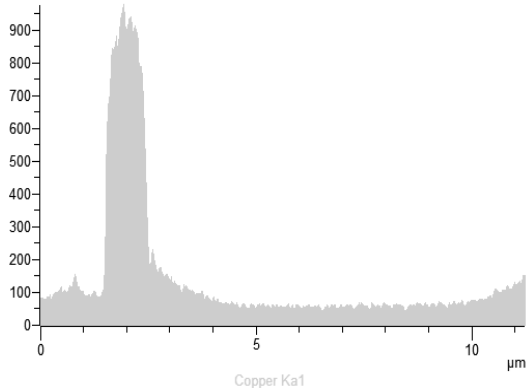

Fig. 6 Copper EDX linescan across yellow line (in Fig. 5)

Zhang et al. studied microstructure and mechanical properties of laser beam welded Al-Li alloy 2060 with Al-Mg filler wire. Their investigations showed that icosahedral quasicrystalline T2 phase formed in the laser welded Al-Li alloy 2060 with lower Li content as a result of segregation and replacement of Mg element [14].

AW2099 Al-Li alloy possesses high strength mainly due to precipitation strengthening. During thermal cycle of welding precipitates dissolved. Re-precipitation was difficult because of high cooling rates characteristic for laser beam welding.

The course of microhardness across base metal – HAZ – weld metal interface is given in Fig. 7. The average microhardness of base metal is 102 HV0.1. The increase of microhardness towards HAZ was observed. The average microhardness in that location was 115 HV0.1. Contrary, the lowest microhardness values were measured in weld metal. The average microhardness of weld metal was 88.5 HV0.1. Observed microhardness drop is associated to the dissolution of strengthening precipitates.

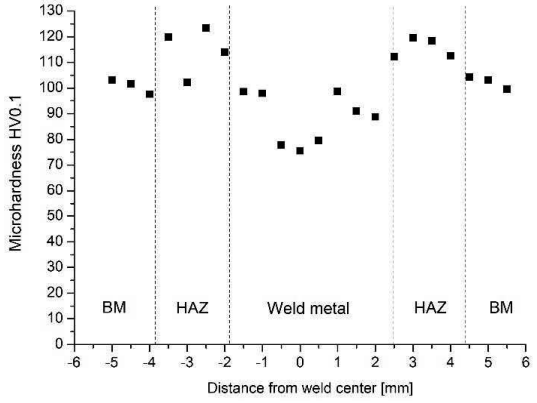

Fig. 7 Microhardness course across BM–HAZ–WM interface

The use of filler metal improved the average microhardness of weld metal. The average microhardness was slightly lower in the case of disk laser welding of AW2099 aluminium alloy without filler metal. The averaged microhardness was 72 HV0.1.

4. CONCLUSIONS

Microstructure characteristics and mechanical properties on disk laser beam welded 2099 Al-Li alloy were investigated in the present study. The major conclusions are as follows:

- equiaxed zone being characteristic for aluminium – lithium alloys was observed at the fusion boundary – weld metal interface,
- columnar dendrites and equiaxed dendrites were found in direction towards the weld joint centreline,
- zirconium led to grain refinement in weld metal,

- interdendritic areas were enriched in alloying elements due to segregation,
- microhardness decrease in the weld metal was recorded due to dissolution of strengthening precipitates caused by thermal cycle.

5. ACKNOWLEDGEMENT

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Migration from TIBCO BW5 to TIBCO BW6 Integration Platform

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Abstract

Business logic migrations through different platforms are common thing in businesses today. Depending on the resources that are at disposal, level of technical expertise in terms of number of trained or certified developers, and finally demand on the market as well as the aspiration to follow market trends, companies transfer their business logics through different platforms. This paper shows the reengineering process by migration from one integration platform to another, saving all the business logic. TIBCO Business Works 5 (BW5) integration platform is a stabile platform that had been around for a long time, but TIBCO communicated that no additional research and development will be committed to BW5, and therefore TIBCO Business Works 6 (BW6), as the next generation platform, was more suited for the DevOps world and hybrid integration platforms. Also, all latest TIBCO integration related products were closely linked to BW6 and made to work seamlessly with the same integrated development environment (IDE), such as BW6 Container Edition, TIBCO Cloud Integration, and TIBCO Mashery. In the paper a case study is presented to compare TIBCO BW5 and TIBCO BW6 integration platforms.

Keywords: Integration platform, Middleware, TIBCO BW5, TIBCO BW6, EAI, Migration.

1. INTRODUCTION

The role of middleware is to allow the flow of communication or data between two different entities. Enterprise Application Integration (EAI) is the way to bring together different applications in such a way that operate as a unit.

Everyone wants the best technology that is out there. As such, big corporations end up utilizing different applications, whether as a third party or as a built in-house, to service their different needs. Large companies might have individual applications that serve their manufactured products, customer base, human resources, and business logic. These four different applications are completely unrelated and built on varying platforms.

There are difficulties in getting these different applications to work together, getting seamless data to flow between applications, and overall system stability. Enterprise application integration employs a form of middleware in which an EAI provider is configured using standardized methods to make connections between the various applications. EAI packages adapt together for connectivity and a transformation engine is configured to transform data into a usable format for the consumer..

Middleware is known to be a software that acts as a bridge between an operating system or database and applications, usually on a network. Integration middleware is the alternate term used for middleware as the purpose of middleware is mainly integration. There are various of integration platforms that are being used, all of

which are based on the same concepts with differences mainly in the execution during development and implementation.

Some of these platforms to develop EAI solutions, beyond others, are: TIBCO Active Enterprise, Mercator Enterprise Broker 5.0, Oracle Integration Server, HP Net Action IOE, IBM Websphere Business Integration Suit, Miscrosoft BizTalk Server 2004, Microsoft .NET, Sun Open Net Environment, Vitria Business Ware, Versata Global 2000, BEA WebLogic Integrator, Web Methods and SeeBeyond E*Gate Integrator [1].

This paper focuses on a TIBCO Active Enterprise platforms, i.e. on TIBCO ActiveMatrix BusinessWorks integration platforms, whose components are designed to support development in phases and to let seamlessly moves from one phase to another.

While the TIBCO designer enables configuration of adapter services and business processes that contain activities provided in the TIBCO pallet, TIBCO Enterprise Administrator allows managing and monitoring those service adapters via process engines that are previously assigned to each of the adapters. There are various types of messaging protocols that are being used. The adapter services are accessed using TIBCO Rendezvous. The web service is accessed via Simple Object Access Protocol (SOAP). The application service is accessed via Java Message Service (JMS).

Following chapters of this paper will describe, respectively, a motivation for doing the research; methodology that describes implementation methods in detail together with the description of a specific use case example; results represent arguments for migration from different perspectives; and conclusion that contains a short summary of the results.

2. MOTIVATION

As the industry environments become increasingly distributed and heterogeneous across multiple organizational and geographical boundaries in recent years, there are strong demands to integrate various distributed applications in order to enhance or increase enterprises' competitiveness [2]. Additionally, the applications and devices may be developed or provided by different vendors with different programming languages, formats, and protocols. Significant integration efforts are required to enhance and increase the interoperability of these applications and devices [2,3].

The main characteristic of the IT world is the necessity for keeping up with the changes and trend fluctuations on the market in order to maintain the business efficiency. Companies may also decide to change an existing IT system or platform and switch to another, newer and improved due to processes of companies' mergers, acquisitions, spin-offs or divisions.

Conversion from an old to a new IT system may save money by re-using the functionality of old assets within the new system. However, money saved by re-using the functionality of old assets will usually be outweighed by the expenses associated with the manual conversion and downtime during the time of change from the old IT system to the new one. In addition, the conversion process typically requires an extensive knowledge of the differences between them and is usually more expensive than a simple upgrade to a newer version of an existing IT system [4]. Since legacy systems represent a considerable investment by an underlying business which will frequently rely on the legacy software for many day-to-day business activities, many companies go with the decision to migrate their legacy code to a newer platform, maintaining the stability of their business practice and keeping up with the technology trends at the same time, not letting their systems to go out of date.

3. METHODOLOGY

For the purpose of this research, a comparison in developing specific service via two different platforms is made. The goal is to show the advantages and disadvantages of each

platform from developers, clients and monitoring team perspective.

Furthermore, this section is divided in two parts, where the first one is focused on description of the use of application and within the second one is shown how the application is implemented by means of TIBCO BW5 and TIBCO BW6 platforms.

3.1. Use Case

The main function of the process is to convert incoming invoices into a readable format so that the Enterprise Resource Planning (ERP) system can process them. The invoices are placed by one of the 4 different suppliers on a special server, also called the communication server. Invoices are in a form of an Extended Markup Language (XML) file with a matching Portable Document Format (PDF) file.

Service client places the invoices into 4 different folders depending on the supplier that is sending the invoices. Each supplier has its own type of message and each invoice has a PDF file as attachment separately delivered as well.

The Enterprise Service Bus (ESB) process' task is to pick these invoices and PDF attachments files up and move them to another server which lies within the domain of another client. The next step is to convert the different file formats of each supplier into a single format that can be understood by the ERP system. Secondary processes are:

- archive the original invoices and PDF-attachments into directories,
- translate supplier-contract numbers into department codes,
- maintain a report of all processing results,
- move invoices with zero-amounts into a separate folder, and
- provide the ability to re-process invoices that have been manually corrected.

3.2. Implementation

In order to trigger the flow for this use case there are 5 interface processes. First one contains a file puller as a start activity that monitors initial location and picks up all the incoming invoices, XML and a matching PDF file. The second one is a SOAP service process triggered manually via SOAP UI testing tool. SOAP is a lightweight protocol for exchange of information in a decentralized, distributed environment. It is an XML based protocol that consist of three parts: an envelope that defines a framework for describing what is in a message and how to process it, a set of encoding rules for expressing instances of application-defined datatypes, and a convention for representing remote procedure calls and responses [5]. Third interface process is a Hypertext Transfer Protocol (HTTP) receiver that handles the client's request for a daily report of an invoices being processed on that particular day. There is another process that handles monthly and summary reports that triggers via timer activity. Last but not least is Replay process that provides users an opportunity to handle some of the old invoices again that have not been processed for some of the following reasons: invalid XML invoice files, no matching PDF files, no contract for an invoice or none of the suppliers are related to the invoice.

All of the exceptions are handled and an email is sent via application to the corresponding users and monitoring team. Once the flow is triggered, main part that obtains an actual invoice processing is invoked and implementation code is shown in Fig. 1 (BW5 code example) and Fig. 2 (BW6 code example) in this paper.

Main process contains mostly call process activities for each supplier invoice that represents an input, and based on it the flow is being redirected. Since each supplier has its own type of the message, implementation of each is handled differently. If a matching PDF file exists, XML invoice file goes through an XML parse activity that extracts the data from elements and transfer it further to the mapper activity in which, based on the element values, arithmetic operations are being executed. With

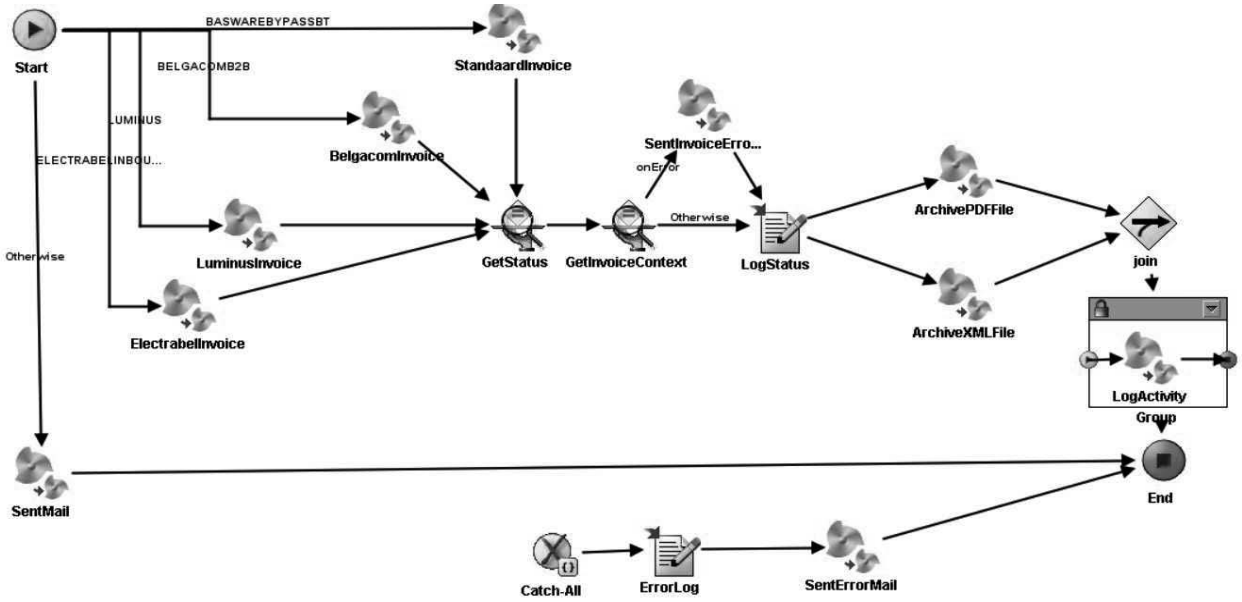

Fig. 1. Invoice processing implementation code via TIBCO BW5 platform

this, the processing of an invoice is finished. Based on the content of an invoice, a status for every invoice is being generated and stored into a shared variable value that main process uses in order to archive invoices properly through the file system. The concept and usage of shared variables and shared modules is of an extreme importance for a developer to be able to reach as high as possible reusability percentage of a code.

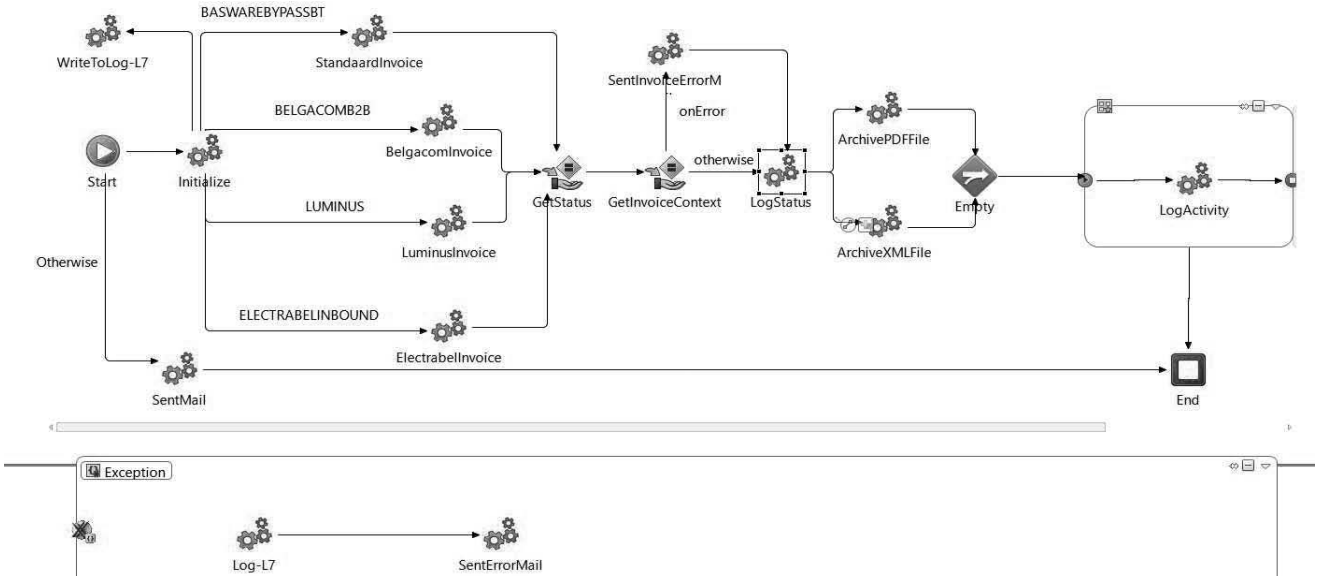

Fig. 2. Invoice processing implementation code via TIBCO BW6 platform

The requirement for this invoice processing BW5 legacy code to be migrated was that the functionality of an application, external invocations and its base implementation methods should remain the same. This, of course is not the reason not to implement all of the possible improvements during migration of the code into the BW6 platform environment. One of the major improvements would be the handling of logs through the application flow. In BW5 all of the log activities are handled by simply writing into a file which content will later be used for debugging purposes. However, in BW6, a usage of shared module is being exploited in such a matter that all of the log activity outputs are being transferred to the

logging process located in the shared module and from there directly written into the log database. Needless to say, how this improvement contributes the saving of resources in terms of memory space, but in addition it also improves a performance of an application and reduces the amount of code. To be able to make a comparison, an implementation in BW6 is shown in the Fig. 2.

This kind of logging procedure is completely reusable and can be adjusted to any application. It is implemented via two simple processes. Implementation of an improved logging procedure via BW6 code is shown in Fig. 3 & 4.

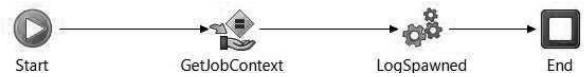

Fig. 3. Write to log procedure implementation code via TIBCO BW6 platform

The *JobContext* shared variable contains the data previously set in the processes that requires logging and those data are being passed to another process that writes the logs into database or into a file. Both options are deliberately provided by this log procedure for the purpose of reusability in order to easily adjust to the possible requirements of an application. Managing the further course of the flow in this case is conducted via simple boolean type of properties: *LogToDB* and *LogToFile*. In addition, a *LogTreshold* property prevents the logs with large payload to be written. *LogSpawned,* the second process, is the next step in the logging procedure (Fig. 4).

Through this example – part of the implementation code, it is inevitable to conclude

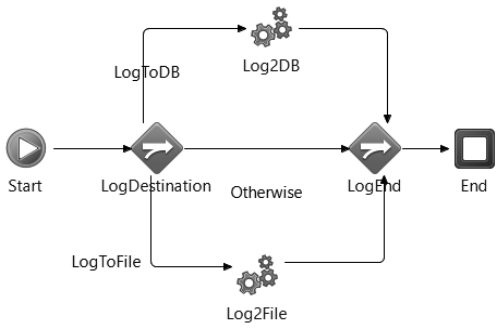

Fig. 4. Log spawned procedure implementation code via TIBCO BW6 platform

why BW6 platform makes life easier from the developers' point of view. However, there is more than one factor that impacts the decision to migrate from one platform to another.

Fluctuations on the IT market in terms of no additional research and development to be committed to BW5, which means that bug fixing or any future feature and plugins will be committed exclusively to the BW6 platform.

4. RESULTS

Reasons for migration to TIBCO BW6 platform, when comparing to the other integration platforms, are various and meet the requirements of various users, developers, designers, testers or administrators. Considering that the platform supports a complete development lifecycle using of native Eclipse features, development, debugging, testing and deployment are all possible in one single environment.

From the developers' point of view, main advantage is easy process, service and API implementation thanks to the intelligent canvas, a mapper that includes auto-complete features and automatic warnings. Besides that, BW6 offers an easy and sophisticated model for compensation handlers that enables defining catch blocks in the form of a scope with activities and exception handlers.

As already mentioned, TIBCO BW6 is an Eclipse/Java base platform which means that the combination of BW6 processes and Java coding is possible. That enables a developer to create a custom TIBCO function using java code and since the function is able to be installed as a plugin it does not affect the performances of an application.

From the client's perspective, one of the main advantages would be the fact that in most tools, each SOAP or Representational State Transfer (REST) service operation has to be implemented as a single process, while in TIBCO BW6, all operations of a service can be implemented in a single process, even both SOAP and REST

services can be implemented within one single process implementation. It is important to mention for the purpose of comparison that BW5 platform does not support implementation of a REST service at all. It is possible only to invoke a REST service.

One of the most important reasons for migration from BW5 to BW6 is the continuous integration and continuous delivery to enable quick releases, bug fixes and change requests of services. BW6 offers a specific Maven plugin, but also supports other tools such Subversion (SVN) or Global Information Tracker (GIT) for version control management [6].

5. CONCLUSION

TIBCO BusinessWorks 5 is a stabile platform that has been available for over 10 years now and will be supported for a very long time since thousands of customers have developed their legacy systems in it. On the other hand, BW6 is a platform to which TIBCO committed all of the future research and development, therefore this platform is seen as the future.

The migration of a code from one platform to another should be performed for the old legacy systems only if it's necessary mainly because of the resources spent in terms of money and time, since not everything can be migrated automatically. However, for the new projects, with all of its features and improvements BW6 is most definitely seen as better solution.

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Implementation of Lean Principles in Mining Industry – Case Studies

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Abstract

Shown in this paper is the implementation of lean principles in mining industry, in form of two case studies, involving mining sites in Nevada, USA and Efemcukur, Turkey. In both cases, the companies struggled to survive due to a crisis, and it was decided to apply lean principles in an attempt to improve their efficiency and reduce the costs. The first case was focused on increasing production, whereas the second case involved better maintenance for the purpose of preventing considerable downtimes. The application of lean management to both these situations provided positive results, allowing both companies to recover and continue with their work.

Keywords: Lean management, Kaizen, mining site, preventive maintenance, validated learning

1. INTRODUCTION

Recently, the concept of lean management has found its use in various areas. Lean mana–gement is based on the following principles:

- identify problems (value),
- map the value stream
- create flow
- Establish pool
- Seek perfection (constant improvement)

In this paper its application in mining industry will be presented. It both cases, the advantages of lean management are shown, but in the different segments of mining industry. The first case that will be shown here is how lean management in a gold mine in Nevada - USA created a strong CI team, and the second case will demonstrate how similar principle of lean management was successfully implemented to improve the maintenance in a gold mine located in Efemcukur –Turkey.

2. HISTORY AND PROBLEMS IN BOTH CASES

The first case mentioned here involves the Round Mountain (shown in fig. 1), that is located in the Nevada, a four-hour drive from Las Vegas. Gold mining represents one of the most developed and important industry branches in Nevada (USA). This area has seen gold production for 110 years; and it had produced 14 million ounces of gold since 1977, whereas right now it has around 900 people employed [1]. Taking into account the isolation of the mine itself, and how lean management was applied to it, it is evident that this approach can reach even the most remote locations and facilities.

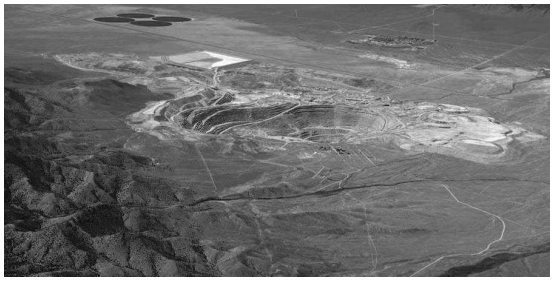

Fig. 1. Round Mountain mine site in Nevada, USA

The mine had a steady and good production, until the crisis in 2012, when price of gold started dropping, and thanks to lean management, a disaster has been averted.

In second case shown, the problems also started with the economic crisis in 2012, when the price of gold dropped to the sink. At the time, Tüprag was commissioning the Efemçukuru site (fig. 2), hoping to start production as soon as possible. To make a difference they increased working hours and pushed workers to the limit and that resulted in total chaos, with production performance dwindling and safety risks increasing. By 2013, it was clear as daylight that the mine couldn't continue working like this. During next year the price of gold kept dropping, putting a strain on mining investments and mineral exploration budgets around the world. It was at this time that he mine turned to the Lean Institute of Turkey in order to implement lean management. Lean principles which were used at Tüprag included the 5S and visual management [2], along with kaizen activities to improve the maintenance.

Fig. 2. Efemçukuru mine site in Turkey

3. IMPLEMENTATION OF LEAN

In the Round Mountain case, they started developing people from the ground up. They started to teach their employees to think lean, and also give them all the necessary information and tools for successful implementation of lean.

There were two basic elements for developing people and these are the use of a continuous improvement board – to encourage them to take a more active role in the improvement of processes – and the creation of cross-functional teams [3].

The selection of cross-functional teams was performed based on where people seemed to be the most receptive and also on the impact these teams would have on the business itself. Senior management pointed employees in the right direction, while still allowing the team members to figure out improvements on their own.

The continuous improvement board (fig. 3) is a management response on how to successfully capture improvement ideas that are given by the employees. In this was, it was possible to make things visual, which helped in maintaining a continuous stream of ideas that originated from all levels of the organization – doing things this way resulted in a total of 500 improvement ideas submitted in one year at the mine site.

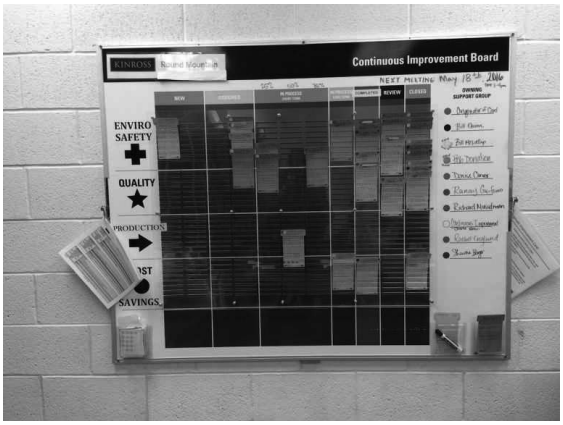

Fig. 3. The continuous improvement board used in Round Mountain mine site

In this case, it is shown that improving without ensuring that everybody knows the ultimate goal of a company is not the right approach. The line-of-sight principle is used – also known as True North to the lean practitioners – to help the employees to understand that the mining site has an ultimate goal and that both departments and individuals have a contribution to make towards it. The ultimate aim of the company is to have a 900-strong continuous improvement team. Here the lean training was gladly accepted with enthusiasm. This is often not the case, as will be shown in the second example. After training, the employees where really trying to make a difference. Sharing with employees the fact that

they wanted all 900 of them to become active improvers was one of the best things to do.

In the second case (Turkey), things were different, and lean training sessions were met with suspicion and resistance. They got responses from employees like: “We are Turkish miners, not Japanese carmakers”, “Mines are different, unique environments” or “You can’t apply 5S underground” [2]. But the management was firm and persistent, thus in six months after the first implementation pilot projects, kaizen had begun to bring results and people started to realize that the philosophy they had resisted can actually help in solving of mining site problems.

The application of 5S and visual manage–ment (continuous improvement board - fig. 4) has resulted in a better-organized underground work area. After the initial positive results were obtained, it was decided that the 5S should be spread to the whole mining site, including all of its departments. As a consequence, 5S audits are now performed in 95 locations across Efemçukuru, above and below the ground alike.

There are two main phases: labor- and equipment-intensive underground production and process- and energy-intensive ore benefit–ciation [2]. At Efemçukuru, the company used TPM (total predictive maintenance) along with early equipment management as a means of solving underground problems, whereas autono–mous maintenance was applied to the rest of the mining site, along the concepts of reliability and energy efficiency.

They encountered two types of problems here, the first was related to the fact that completing one cycle took too much time. That actually means that they evaluated both value-creating and non-value-creating operations. Thus, by doing this, they were capable to see the problem and to solve it by creating standardized material areas with storage bays that are refilled every hour. In this way, waiting times and material waste were eliminated, and as a result, the cost per meter excavated was reduced.

The second problem was that the overbreak (excess material after excavation) was high. This means that every transport and processing operations represented pure waste, which resulted in capacity loss in the plant and great inefficiency. By implementing kaizen, all available ore face engineering applications were repeatedly questioned by mining engineers and training on each technique was given to each employee. The final result has been millions of dollars in savings.

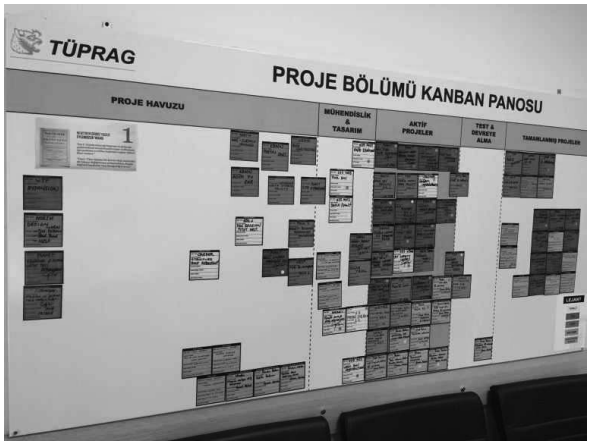

Fig. 4. The continuous improvement board used in Efemçukuru mine site

4. BENEFITES OF INTRODUCING THE LEAN

In the Round Mountain case, the biggest success of lean was shortening the time between finding the ore and delivering it to the processing department. When determining the quantity of material that could be carried by a truck, they used to guess the amounts, which usually resulted trucks being under- or over-loaded – they had always worked that way and nobody ever told them anything different. Here, the visual management played a vital role, and illustrations were of vital importance, so communion improvement board shined in their best light. This was a great way for minimizing of operating costs, as a lot more haulage was achieved with the same number of trucks and for same amount of fuel.

Another great example of improvement by lean was the shift change. A mining site is quite different from a factory: it is necessary to have people on the field at all times and inspect the

trucks before getting them on the road, resulting in shift changes being all over the board. By accurately measuring them, it was possible to develop standards which significantly shortened the travel time and the delay between shifts.

What is also important is that with lean approach constant maintenance of mining equipment and preventive repairing is introduced, and with that, the mining site downtime is drastically lowered. Hence, the amount of money lost due to the mining site not working is minimized.

In Turkey, the implementing lean management approach was an even bigger success, since they started monitoring crucial equipment and with that they could intervene before failure occurs (preventive maintenance). After identifying the sources of problems they placed Fuguai Tags [4] at the affected machines. The routine maintenance was introduced, and in this way, rather than constantly putting out the fires, the team is now performing root-cause analysis to eliminate faults once and for all. By doing thing like this, the breakdown rate has decreased. Early equipment management was also extremely useful, because prior to applying of the lean approach, the mine site used to spend hundreds of thousands of dollars in mobile equipment for mine production that they could not even properly use most of the time. Kaizen was instrumental in tackling these challenges, but it's certainly not the only element of a lean transformation that was relied upon.

5. DISCUSSION AND CONCLUSIONS

The transformation that took place in both mining sites after implementing a lean approach is nothing short of a revolution. This is more than just the combination of a couple of technologies, innovations or investments, the important thing here, which has to be the main focus, is a structured, purpose-driven effort to unleash the creativity of employees and develop their capabilities.

Lean wouldn't be lean if it didn't benefit everyone involved, including all of the community related to the mining site directly and indirectly.

Hence, this study presented a very specific application of lean, under somewhat extreme circumstances (the isolation of the facilities in question), and it was determined that both cases gave successful results, even when the implementation was not initially accepted by the employees. It also pointed out the advantages of maintenance and standardization of activities and process in a typical mining site, while emphasizing the advantages of lean methodologies in terms of cost-effectiveness and production efficiency.

6. ACKNOWLEDGEMENTS

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LEAN Approach and Risk Management

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Abstract

Today's age is characterized by accelerated technological development, changes in the natural environment (extreme climate change) and rapid and turbulent socio-economic changes. Customer are becoming more demanding, markets are becoming more dynamic & open, product life-cycles are getting shorted In order to increase the productivity of the people involved and to minimize risk, business has turned to process. But the process steps also need to be resilient against disruptions to quickly return to their normal state This creates a pressure on processes and therefore they become inefficient & wasteful. LEAN is modern answer to business challenges which involves new approaches and tools which can be used in risk management too and this is the topic of the presented paper.

Keywords: lean approach, risk management, error proofing

1. INTRODUCTION

1.1. Lean thinking

The term “lean thinking” encompasses a set of lean practices and was first proposed by James P. Womack et al.(1992). It can be considered that the lean paradigm is:

„use less of everything – half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering working hours to develop a new product in half the time. Also, it requires keeping far less than half the inventory on site, results in fewer defects, and produces a greater and ever-growing quality of products“, [1] . (Womack, Jones, and Ross 1990).

Inspired from the Japanese management methods, the LEAN approach is intended to have the enterprise think first and foremost about maximizing the value that its products and services can bring to the client. The core idea is to maximize customer value while minimizing waste. Simply, lean means creating more value for customers with fewer resources. A lean organization understands customer value and focuses its key processes to continuously increase it, [2]. (Kirin, Kirin, Sedmak and Arandjelovic, 2018).

From that time to the present day, the popularity of lean thinking has spread in the business world.

The core idea of lean manufacturing is relentless work on eliminating waste from the manufacturing process. Waste can take many forms, but the basic idea is to eliminate anything and everything that does not add value from the perspective of your customer. Waste is any step or action in a process that is not required to complete a process successfully. When Waste is removed, only the steps that are required to

deliver a satisfactory product or service to the customer remain in the process.

Lean management strived to eliminate seven kinds of waste including waste from overproduction, waste of waiting time, transportation waste, processing waste, inventory waste, waste of motion and waste from product defects.

Objectives of lean enterprise transformation are: less waste, less design and production time, continuous flow, less costs, more employee empowerment, fewer organizational layers, fewer suppliers, more flexibility and capability, more productivity, improved quality, higher level of customer satisfaction and long-term competitive success. Three key pillars of Lean are physical workplace, process and people.

5S methodology is utilized by Toyota in the 1970s. The core of 5S methodology is to provide a clean, tidy, safe and productive workplace. The 5S Methodology offered each employee a level of importance and encouragement that every job was essential to the process and end product. Waste was kept to a minimum and workspace organization led to timely outcomes with genuine employee pride.

The value specification process elaborates on the outcomes. In this process the key stakeholders determine first their values (economical, social, enabling sustainability, environmental and behavioural) and then rank them based on their importance achieve their goals. Value is determined by the customers who want to buy the right product with the right capabilities at the right price. Different values are: quality, design, price, durability, variety, ease of use, maintenance level.

Lean thinking changes the focus of management from optimizing separate technologies, assets, and vertical departments to optimizing the flow of products and services through entire value streams that flow horizontally across technologies, assets, and departments to customers. Manager’s role changes from directing and inspecting work to coaching, facilitating, resolving only the highest-level issues, and ensuring that people have the skills, information, judgment, and relationships that allow them to deliver vastly improved results

Learning instead of blaming becomes the focus of every mistake, missed opportunity/goal. Training and development are a constant high priority.

At Toyota, millions of employee suggestions are generated every year, with an adoption rate of over 90 percent.' By contrast, many non-Lean companies' suggestion programs are dormant and ineffective. Principles of lean production are

- Continuous Improvement - promotes constant, necessary change toward achievement of a desired state. The changes can be big or small but must lend itself toward improvement
- Respect for humanity - constant communication, praise of a job well done, listening to their ideas and helping out when necessary. When people do not feel respected, they tend to lose respect for the company.
- Leveled Production - the main tool for this lean manufacturing principle is utilization of a pull system.
- Just In Time Production - to build what is required, when it is required and in the quantity required (works well with Kanban - a pull system)
- Quality Built In - design of the part, into the manufacturing process, into the packaging, shipping. Quality is a major consideration.

1.2. Risk management

The risk is usually defined by the probability of the occurrence of an unwanted event and its consequences. The common frameworks established by a risk management plan involves six steps: establishment of safety goals; identification of risks and resources; assessment of risks; prioritization and implementation of

actions; monitoring of effectiveness and improvement according to new circumstances.

Risk management tools and techniques could be qualitative, quantitative or combined. Qualitative are root cause analysis, hazard analysis, brainstorming, process mapping and analysis, taxonomy-based questionnaires, Pareto method, affinity grouping.

Some of quantitative methods are stochastic and deterministic Modeling like Probabilistic Risk Assessments (PRA) and Other Statistical based Modeling and Analysis techniques; Cause & Effects Analysis like Failure Modes & Effects Analysis (FMEA) and Failure Modes, Effects & Criticality Analysis (FMECA), Fault Tree Analysis (FTA); Systems Engineering Analysis and Risk Assessments.

Risk management goals and objectives should be consistent with and supportive of the enterprise's business objectives and strategies. The organization's business model provides an important context for risk management. Aspects of safety research include: human factor, reliability and safe engineering, highly reliable organisations, cognitive engineering, interaction between man and machine, natural decision making, safety culture, learning from accidents and research, risk perception and regulation.

Technologies and ecosystem factors are considered depending on the classification of risks. High-risk systems are systems that are complex in themselves (new technology, interconnected components) and / or use hazardous substances in the workplace. The development of technology creates constantly new risks. The risk assessment for equipment is based on historical data, maintenance data or manufacturer declarations (for new equipment).

Human error can be the result of operator fatigue, insufficient training or lack of training to work under certain conditions or apparatus, disregard of rules and regulations, cognitive constraints in complex tasks or health problems during work.

When it comes to the methodology of risk safety research, it can be said that security is a dynamic "no event since the purpose of assessment and decision making is to ensure that the unwanted event does not occur. This raises question: In which way and by which methods can "non-event" be analysed. In old technologies, the danger is the age of the equipment, and its projected lifetime is an important data for assessing the degree of risk. The figure 1 is a model of the most important factors affecting risk management process.

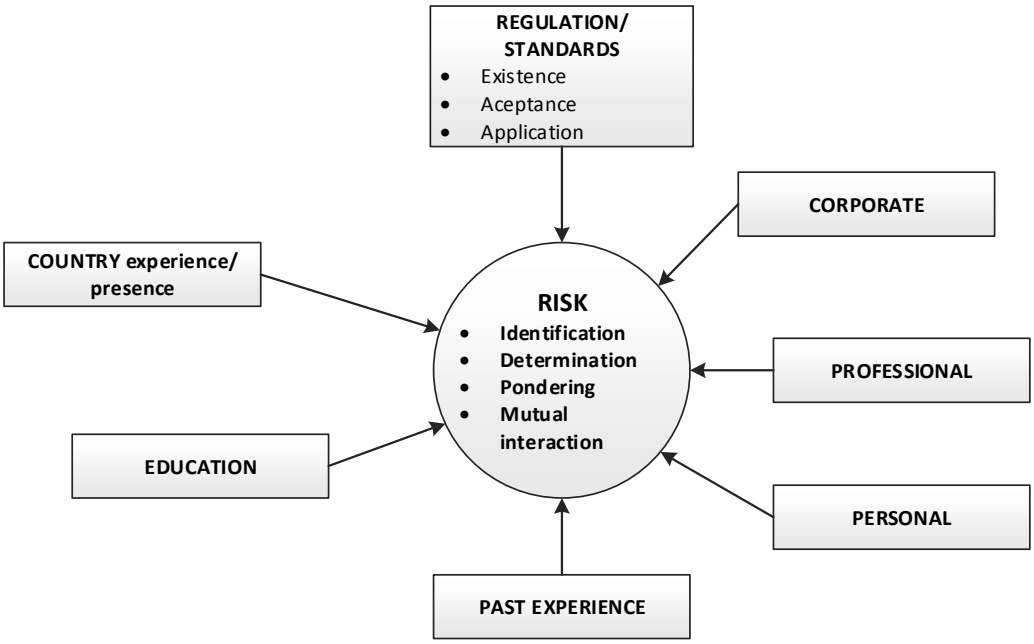

Fig 1 Factors related to risk management

2. LEAN AND RISK MANAGEMENT

It is necessary to present in details assumptions of study to such an extent manner that a reader could repeat that work if he/she was going to confirm achieved results. This information should be given in as short as possible version.

2.1. Lean production tools related to risk end error proofing

Assessing manufacturing readiness level is performed to define the current level of manufacturing maturity, to identify maturity shortfalls and associated costs and risks and to provide the basis for manufacturing maturation and risk management.

Traditional risk management approaches, based on the static risk assessment leading to control established before the risk activity has occurred are not suitable for the dynamic development and rapid changes in the environment, particularly in emergency conditions, [3]

„Value stream map" became an common term and central approach of lean methodology in many places. Value stream mapping also came to be used in Six Sigma methodologies. The first step toward creating a lean environment – increasing value and removing waste – is analyzing the value stream. This provides the foundation for creating an improvement plan. By examining the current state of a system, actions that add to value creation can be clearly separated from those that create waste, making it easier to locate opportunities for improvement.

A3 Lean tool is known as „The A3 Thinking Process“ and can be applied in almost any problem situation. It consists of the ten steps : Identify a problem or need, Understand current position, Target, Root Cause Analysis, Countermeasures, Implementation plan, Follow-up plan, Involve affected parties, Approval, Implementation and Evaluation.

The “5 Whys” is a technique which by repeatedly asking the question “Why” in maximum five steps leads to the root cause of a problem. Every “why” should remove one layer of a problems and discover new symptoms.

Poka-yoke means methods or devices to improve product quality and ensure consistent process results and avoid defects. „Defects” are the results, but “Errors” are the causes of the results.

Defect can be simply defined as a variance between expected and actual. Defect is an error found AFTER the application goes into production. In other words defect is the difference between expected and actual result in the context of testing. It is the deviation of the customer requirement.

The goal is to understand the concept and practice of zero defects and how to develop Poka-yoke to eliminate these defects.

Mistake proofing, or its Japanese equivalent poka-yoke (pronounced PO-ka yo-KAY is any mechanism in a lean manufacturing process that helps an equipment operator avoid (yokeru) mistakes (poka).

Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to human errors as they occur.

The concept was formalised, and the term adopted, by Shigeo Shingo as part of the Toyota Production System.

2.2. Risk management

In high risk systems, building of a safety culture is important, and represents a long-term, continued process. During radical changes, it is of great importance for the safety aspect to study the hazards caused by beliefs and mindsets, both individual and collective.

The human factor is one of the main subjects of risk management, which is difficult to predict. Human factors lead to hazardous situations due to error, failure in operation, or due to some disorder.

In risk management, perceptions of risk by decision makers and their assessment of hazardous activities and / or technology are essential. Practice shows that risk perception plays an important role in the adoption of security policies, providing a basis for understanding and anticipating adequate responses to potential hazards. Risk perception is an important factor in improving communication and risk information between technical experts and decision makers, [4].

2.3. Principles of lean approach and risk management

Risk management is the topic of scientific research for a longer period then lean approach. During that period, a clear set of principles was developed. Principles of lean are less strict. We recast the understanding of lean into a set of such principles which we can compare and contrast with those from risk management, table 1. It could be seen that there is very good fit between them.

According to Pearce and others, [5], the main difference in the function of risk management is to explicitly address uncertainty, whereas lean explicitly addresses wasted effort through the optimisation of flow. In the risk management there is value to protect and lean approach is focused on providing customer value.

Both approaches are dynamic, systematic, structured and based on existed data. Both implementations consider cultural factor, respect human, aim to affect the entire system, both approaches facilitate continual learning and improvement of the organisation.

Table 1. Lean and risk management principles

Lean principle	Risk management principle
Creating value for customer	Determine values for protection
Part of the production process	Part of every production process
Its tools help the decision-making process	An important part of the decision-making process
Deals with „waste"	Deals with uncertainty
It has structured, systematic dynamic tools and methods	Has systematic, structured tools and methods
It is based on data about current conditions and values for customer	It is based on the best available data and information
Respect humans and create "lean" organisational culture	Deals with organisation culture and human factor
Observes the entire system and solves problems of flow and bottlenecks	It looks at the whole system and its critical parts
Promote continuous improvement	Continuously learn from previous mistakes

3. RESULTS

By applying the comparative analysis of the principles of risk management and lean principles, it can be seen that they clearly fit. Because of that, tools developed in lean management can be easily applied in order to improve risk management. Fig 2 presents risk management cycle and appropriate lean tools with aim to improve process of risk management.

4. CONCLUSIONS

Lean processes have risk associated with them, and lean approach developed tools which can bring benefits in risk management through decreased number of failures, less errors and mitigation of bad impacting various areas. Supporting lean to meet business goals is the decision of top management teams. The same teams deals with the highest importance risks and building a culture for sustainability. This involves selecting the right methods at the right time and it is shown that principles of both, risk management and lean approach are the very similar and techniques from lean approach could improve risk management.

Fig. 2. Risk management process and lean tool

5. ACKNOWLEDGEMENTS

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Numerical simulations of crack growth in integral stringer panel using XFEM

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Abstract

Shown in this paper is the implementation of lean principles in mining industry, in form of two case studies, involving mining sites in Nevada, USA and Efemcukur, Turkey. In both cases, the companies struggled to survive due to a crisis, and it was decided to apply lean principles in an attempt to improve their efficiency and reduce the costs. The first case was focused on increasing production, whereas the second case involved better maintenance for the purpose of preventing considerable downtimes. The application of lean management to both these situations provided positive results, allowing both companies to recover and continue with their work.

Keywords: Extended Finite Element Method, Integral stringer, Fatigue crack growth

1. INTRODUCTION

Morfeo/Crack is a software product for the computation of the stress intensity factors (SIFs) along the front of three-dimensional cracks and the prediction of crack propagation under fatigue loading using the extended finite element method (XFEM). XFEM is an extension of the finite element method that allows the presence of cracks inside the elements and offers a high precision on the stress singularity at the crack front with special enriched degrees of freedom.

Between each step, it reads the Abaqus solution, recovers richer, improved XFEM solution in a small area surrounding the crack using a tailored integration rule, accurately computes the stress intensity factors which determine the crack advance and updates the Abaqus input file with the new crack position. Moreover, Morfeo/Crack for Abaqus profits from the nice and intuitive user interface Abaqus/CAE since it is integrated in the latter as a plug-in for the definition of the initial crack position and the specific data for fatigue crack propagation. Finally, Morfeo/Crack for Abaqus offers the choice between post-processing the results in Abaqus/CAE as usual or in a freely available post-processor (gmsh), which renders the solution at the crack tip.

2. NUMERICAL MODEL

Numerical simulation of crack growth has been performed on 4-stringer plate shown in Figure 1. In this simulation two Al alloys, AA6156 T4 and AA6156 T6, were used (Young's modulus E = 71000 MPa, Poisson's ratio ν = 0.33), with different coefficients for Paris equations: m = 3.042 and C=4.7.E-011 MPa $mm^{1/2}$ and m = 3.174 and C=1.77.E-011 MPa $mm^{1/2}$, respectively, [1]. The central crack of the length a_0=14 mm was initiated and the load identical to that used for the same pervious model was applied.

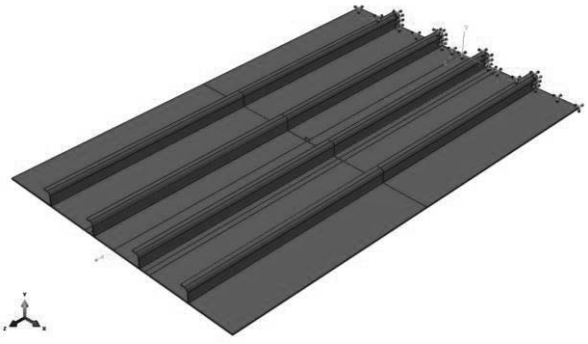

Figure 1. Model of 4-stringer plate with 3D crack used in simulation

The crack was propagated in total of 173 steps (in each step crack length increased by 2 mm) and after 68 steps, it reached the wall of the left stringer and began to spread along it (Figure 2).

At the same time crack continued to spread through the base metal plate, reaching the wall of the right stringer after 78th step (Figure 3) and beginning to spread along that stringer.

The crack is continuing spreading along the base metal to completely damage the both stringers after 130 steps. This can be clearly shown from (Figure 4).

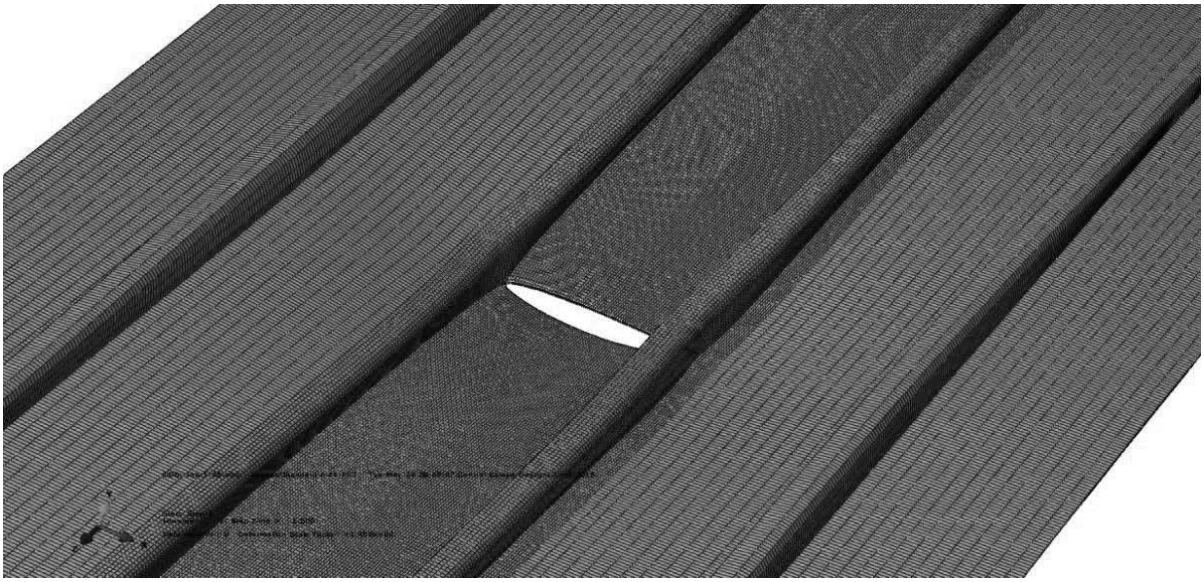

Figure 2 Crack in 4-stringer plate after 68 steps of propagation

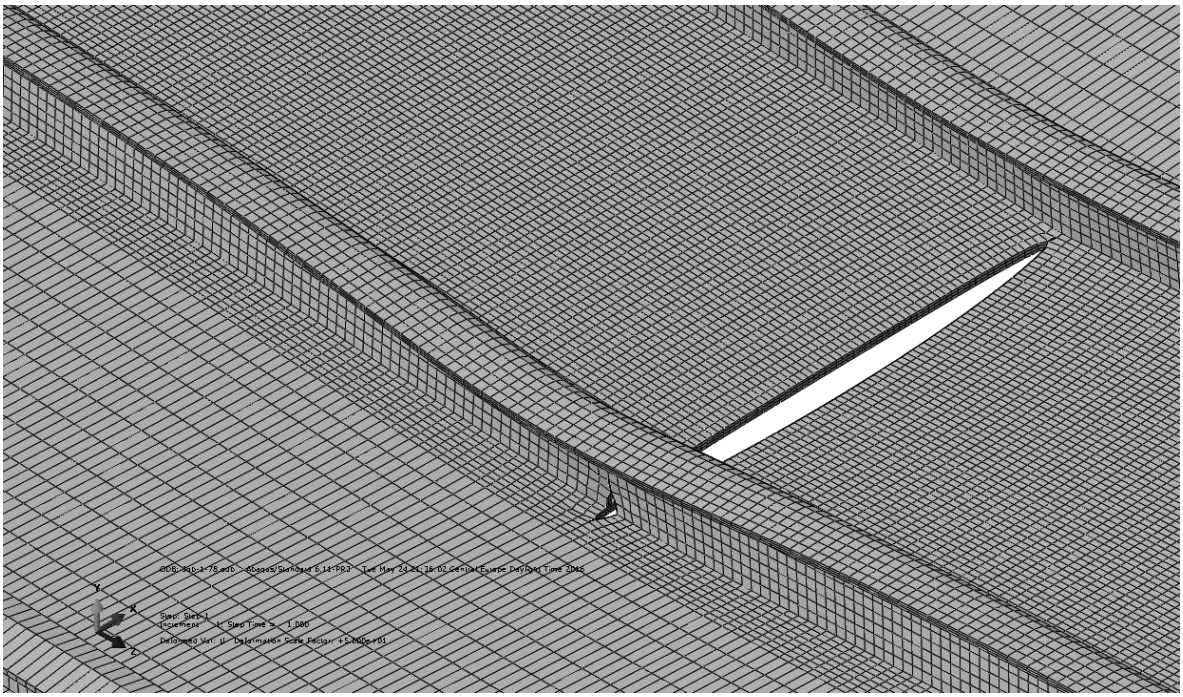

Figure 3. After 78 steps crack begins to spread along the stringer.

During the 160th step complete failure of the left stringer occurred (Figure 5), after which the crack continued to spread along the right stringer and through the base metal plate.

Simulation of the crack growth stopped after 173 steps because the number of load cycles necessary to propagate the crack by 1 mm dropped under 100, indicating that the crack started to propagate rapidly.

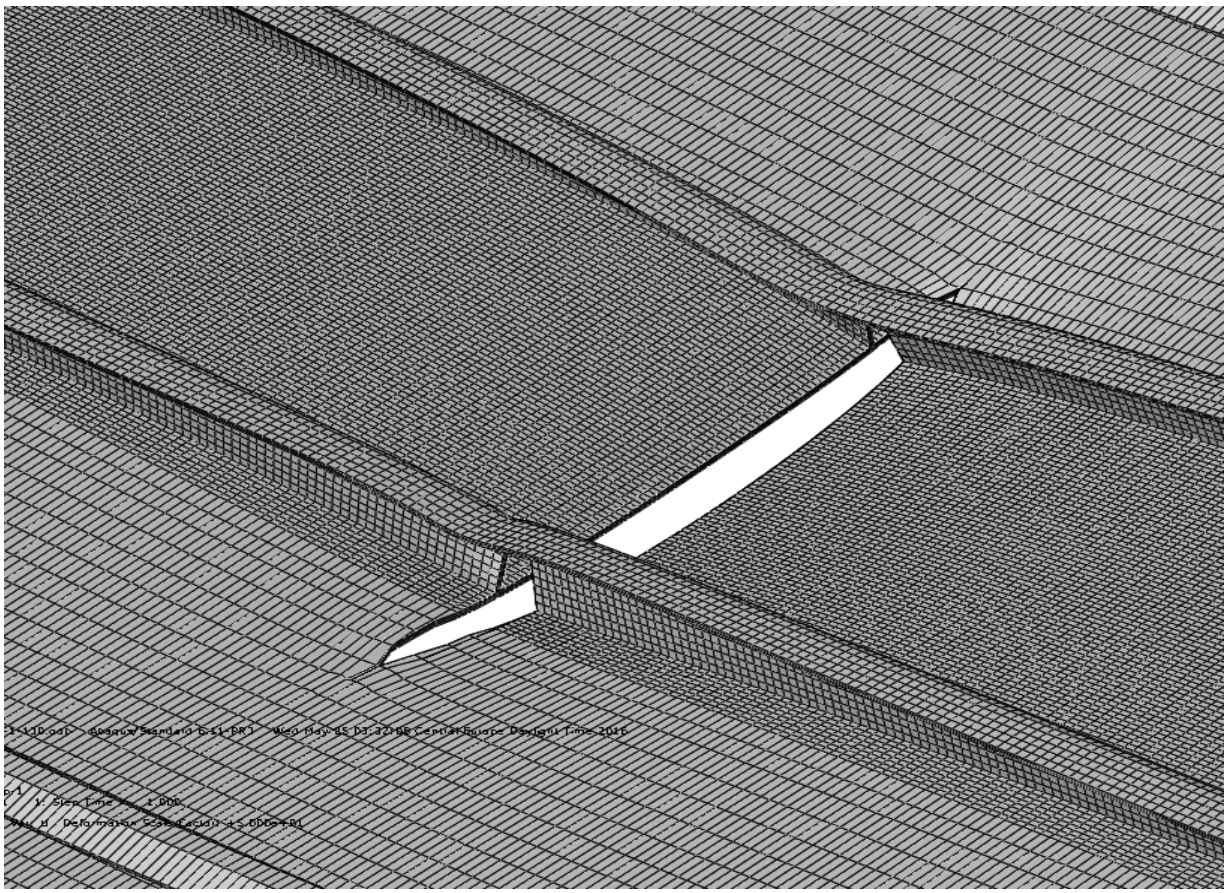

Figure 4. Crack after 130 steps of propagation: both stringers are highly damaged.

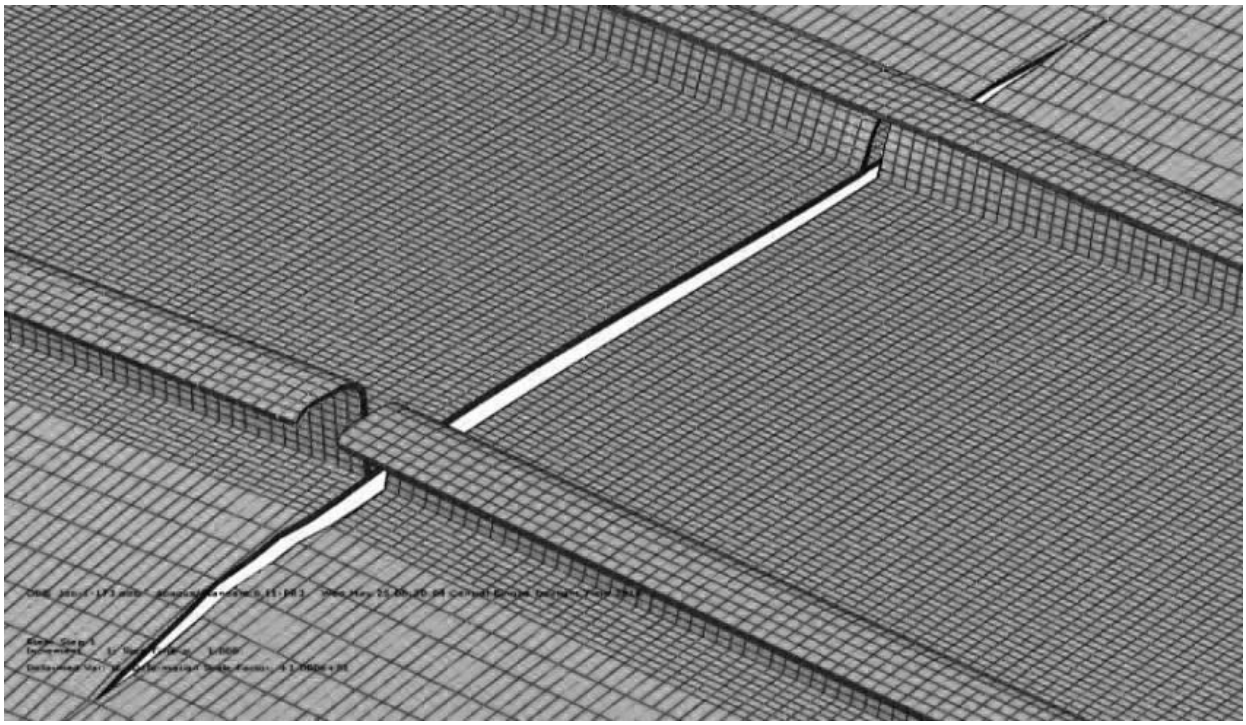

Figure 5 Crack after 160 steps of propagation.

3. XFEM ABAQUS RESULTS

The crack growth results data is obtained by XEFM for materials, i.e. different Al alloys, and presented as the Number of cycles (N) vs. Crack length a (mm), Fig. 6. Significant effect of material resistance to fatigue crack growth is evident, with approximately twofold longer fatigue life in the case of AA6156 T4.

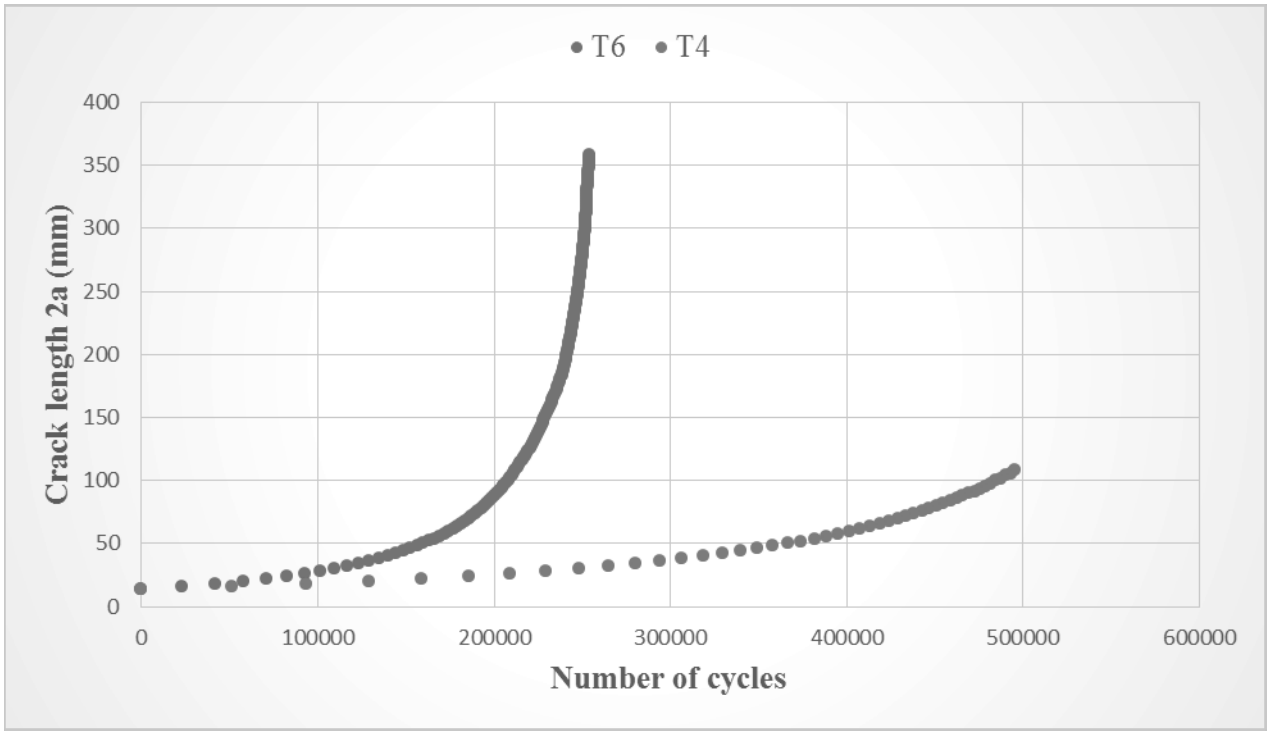

Figure 6. Crack propagation vs number of cycle N for T6 and T4 alloys.

4. CONCLUSIONS

Numerical simulation of fatigue crack growth has been successfully performed by using the extended FEM, as built-in in software MORFEO/ ABAQUS. The effect of material properties, i.e. resistance to fatigue crack growth, has been shown.

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EDUCATION

Measuring Student Satisfaction with e-Learning Platform

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Abstract

In today's rapidly changing environment, higher education institutions as business systems are also struggling for competitive advantage and a leading market position. In a last few years, increasing attention has been devoted to distance and e-learning, as one of the determinants of competitive advantage in higher education. Evaluation of educational service quality is essential for providing a feedback on the effectiveness of educational systems in order to create high quality services. Considering the trend of wide usage of online technologies in the higher education sector, the aim of this study is to measure student satisfaction with e-learning system in order to improve their educational experience. Therefore, in this research SERVPERF method will be used for measuring student satisfaction with e-learning platform. The research was conducted at the Faculty of Technical Sciences, University of Novi Sad, and research results indicate increased satisfaction with the application of new technologies in education.

Keywords: e-learning, user experience, education, service quality

1. INTRODUCTION

This paper presents the analysis and evaluation of electronic learning among students of the fourth year at the Faculty of Technical Sciences in Novi Sad. The aim of this paper is to examine the students' perception of electronic learning as well as their satisfaction. Considering that the faculty already applies electronic learning, it is important to investigate how students respond to this kind of distance learning. Due to rapid technology development and improvements in educational area, faculties which apply-learning systems need to follow the changes and trends in this field, regularly inform their users and conduct market research in order to maintain customer satisfaction at the high level.

2. LITERATURE REVIEW

There are many theoretical perspectives about e-learning. Author Kuhn describes a different way of seeing in education, "system of interest" is advocated for education designers of contemporary learning environments involving substantial e-learning dimensions [1]. Segrave et al. think that contemporary learning environments still demand teaching excelling in older forms of traditional media teachingandin-person, but also creative adaptations to e-learning opportunities [2]. Wang et al. consider that the extent of satisfaction can be measured by the model, SERVQUAL [3]. Kigundu showed that there is four categories of e-learning tools that can be used to enable and sustain students' engagement in the learning processes in higher education [4]:

- learning management system (LMS),
- synchronous collaboration applications,
- other computer tools/applications including asynchronous communication applications,
- game play or simulation software;

Misut's practical recommendations and methodological materials in this field (etc. development of education content, communication of e-learning participants, related to the organization of education, proposals for legislative changes regarding the rights and obligations of e-learning participants, counting workload of teachers in e-learning) indicate positive influence not only on education quality , but also on overall improvement of attitudes of e-learning participants, and thus the whole atmosphere in the institution [5].

3. METHODOLOGY

The methodology used in this research is the SERVPERF model. The questions were designed to contain all 5 dimensions of this method in order to properly understand user expectations and perceptions. For these reasons it is necessary that each examined student realistically evaluates his satisfaction in order to realize the correct application and significance of this method when analyzing and evaluating the quality of service [6]. The survey was carried out electronically, through the platform for distance learning. The students answered 23 questions that were divided into 6 sections and were related to their satisfaction with their learning process and the platform itself. These questions were rated by 5-Point Likert Scale, where 1 represents that they absolutely disagree with the given fact, and 5 represents their complete agreement with the presented fact [6]. This research used the survey presented by Udo et al. which consists of 5 dimensions [7]:

Empathy

- *Moodle* is made according to the individual needs of students
- *Moodle* helps the student's best long-term interests
- *Moodle* encourages student activity

Trust

- *Moodle* contains all the necessary materials
- *Moodle* has a good rating system
- *Moodle* as a system provides security

Tangibility

- *Moodle* provides quick and efficient reaction to students' needs when they using the materials
- *Moodle* gives students the answers to questions for a instructor
- *Moodle* system supports students' questions and comments

Reliability

- When students do the tests, the *Moodle* system does not make a mistake
- When students submitthe homework, the *Moodle* system regularly updates their activities
- *Moodle* system supports secure update of all students' data

Quality Score

- *Moodle* uses audio elements properly
- *Moodle* uses video elements properly
- *Moodle* uses animations/graphics properly
- *Moodle* uses multimedia features properly
- *Moodle* provides useful information
- *Moodle* provides accurate information
- *Moodle* provides high quality information
- The information on the *Moodle* is relevant to students.

In support of these in this paper will be presented two research questions:

- How are students satisfied with the content provided on the e-learning platform?
- Does ''Empathy'' has a positive association with students' perceptions of e-learning quality?

4. RESULTS AND DISCUSSION

Expected results will be mean in regards to the theoretical framework that underpins the research. Early studies in application of service quality in new education system show that students are satisfied with this way of learning [8]. Furthermore, early study showed positive association with students' perceptions of e-learning quality [7]. In accordance with early research, both research questions are discussed via radar diagrams which are shown in Figure 1 and 2.

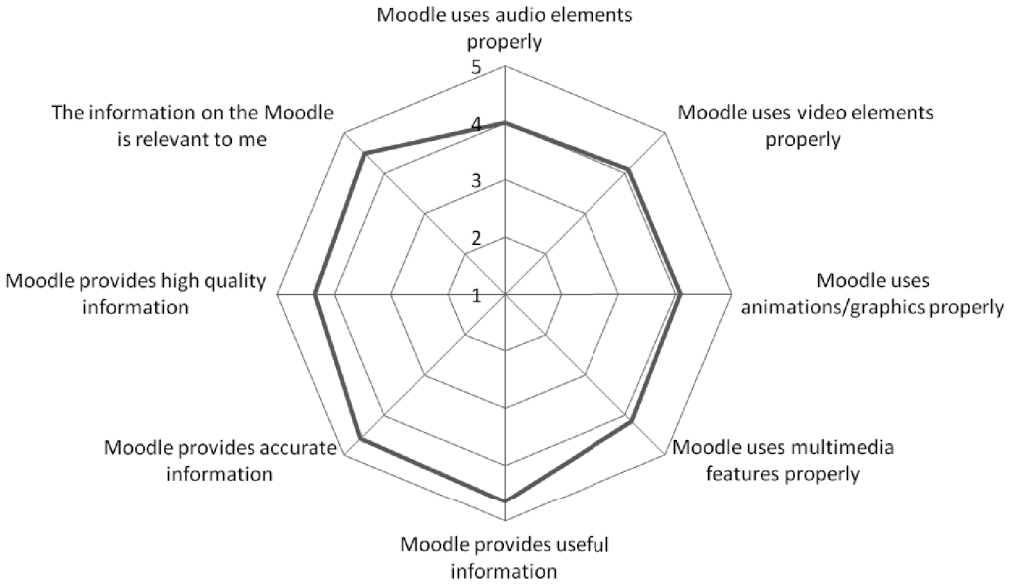

Fig. 1. Students' satisfaction with the content provided on the e-learning platform

Figure 1 shows students' satisfaction with the content provided on the e-learning platform. Eight questions measured the quality of *Moodle* content and their mean is 4.30. It can be concluded that students are very satisfied with the content on the e-learning platform.

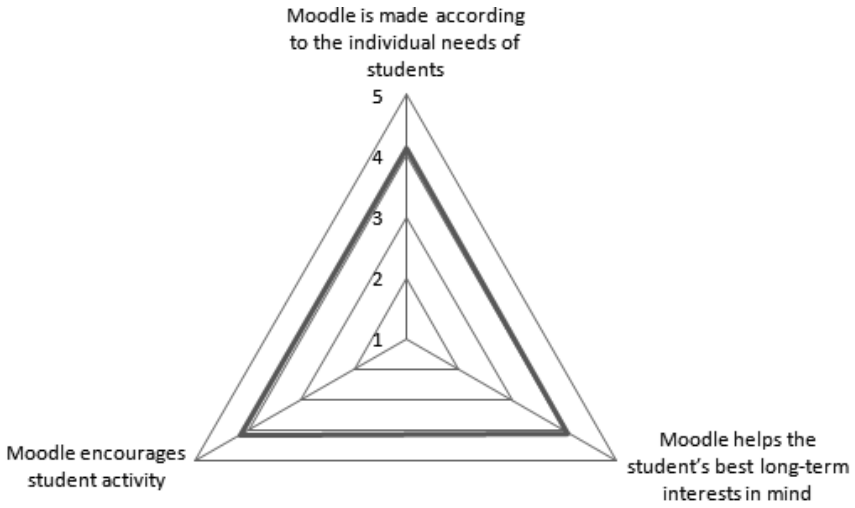

Fig. 2. Empathy dimension

Figure 2 shows Empathy dimensions. Students' answers to the three questions raised within this field, resulted with the mean of 4.12, of the empathy dimension. According to this result, student's empathy has a positive association with students' perceptions of e-learning quality. However, there are capacities for improvements. In addition, Quality Score assessment criterion with grade of 4.30 has the least deviation, and the largest deviation has the empathy rating criterion with grade 4.12.

5. CONCLUSION

This research examined the application of SERVPERF model in e-learning platform. Research was conducted at the University of Novi Sad, Faculty of Technical Sciences with the group of students from Engineering Management. The results are consisted with previous research, which showed that students' empathy has a positive association with students' perceptions of e-learning quality [7]. From the survey results it can be concluded that the current quality of e-learning at *Moodle* is satisfactory among students. The weakness of *Moodle* could be the lack of using multimedia content on the platform, which was estimated by students with lower grades. Future analyses could conduct a core research with a high number of different courses at the e-learning platform *Moodle*. Hence, authors could compare results from different courses and see student satisfaction with e-learning.

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Nonverbal Communication and Body Language in the Business Environment

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Abstract

Nonverbal communication is communication without words. It plays a major role in human interaction. Every bodily movement, whether it is deliberate or involuntary, sends a specific message to the receiver. That message depends on the context, of the surroundings in which people are present, of the culture they belong to, etc... The human body, face, eye movements and touch complement a person's speech and in that way communicate a person's mood and outlook on things. Non-verbal communication complements explain and determines the course of the communication process. It is therefore very important to get acquainted with the ways of nonverbal communication and mastering that skill so that the mood of the interviewer is better detected or presented. The main goal of this paper is to study and investigate how nonverbal communication and body language affects an individual in a business environment. There is no second chance for a first impression so this paper demonstrates better understanding and, application of body language. As part of the work carried out a survey which is a concrete example shown what role has the body language in everyday human relations. The answer is; a very important role. People are unconsciously reacting to the negative emotions of the interviewee and on that basis, the respondent is negatively evaluated, and vice versa.

Keywords: nonverbal communication, body language, business environment

1. INTRODUCTION

Provided that what is spoken and expressed by word belongs to verbal communication, accordingly nonverbal communication belongs all that is not expressed verbally; facial expressions, body language, movements of the head, hands gestures, view ... In general, speech is used to transmit information, and nonverbal communication to transmit mood. Nonverbal communication is not completely removable in the overall understanding of the problem of the communication process. It often complements, clarifies and determines the course of communication. A loving smile tells happiness and good mood opens the way of relaxation and calms the atmosphere. Shrugging tells ignorance or disinterest. Nail biting indicates nervousness and anxiety. This is only a part of transmitting certain messages to the interlocutor, and these messages can be transmitted consciously or unconsciously. It is therefore very important to get acquainted with the ways of nonverbal communication and mastering that skill so that the mood of the interlocutor is better detected or presented.

2. NONVERBAL COMMUNICATION AND BODY LANGUAGE IN COMMUNICATION

Before the appearance and evolution of language, body language was a communication tool that served the understanding of the

messages that were to be sent or received. During human history, and especially in modern times, it becomes a subject of study and a better understanding.

The study of the skill of nonverbal communication began with the appearance of the silent film. Actors had to learn how to show feelings, attitudes, and position in society by imitating the body language they embodied. However true pioneer in the study of the body language of humans and animals was Charles Darwin in his book The Expression of the Emotions in Man and Animals of the 1872nd [1]. Serious study of body language occurred in the 60s of the last century when body language became a subject of study in many areas such as anthropology, social sciences, psychiatry and even economics [2].

Nonverbal communication is all that is not expressed in words when communicating. It takes place by means of non-verbal signs, for example, gestures, posture, touching, facial expressions, view and etc.

People pay eager close attention to the messages that they read each other´s faces and analyze the signs that their interlocutor sends with his facial expressions such as surprise, fear, disgust, anger, happiness, and sadness.

In addition, one of the important parts of understanding the message that the recipient decodes from the sender is also a head movement (nodding as a sign of approval and shake the head indicating disagreement).

It is equally important and eye contact. "The view refers to the individual viewing behavior, which can, but does not have to be directed towards to another person. Mutual view refers to a situation in which two persons interact with one another, usually in the face." [3]. The basic function of the view is to regulate the communication flow, to monitor feedback, to show cognitive activity, and to express emotions.

The human body is capable of a wide spectrum of movements that, besides the primary functions needed in everyday life, also serve to send and receive conscious or unconscious messages in nonverbal communication. Some of the most basic moves are:

- the usual movement of crossed arms, which is "… the universal gesture that indicates the defensive or negative mood" [4],
- crossed hands with a squeezed fist, which means that a person "... took up an enemy and a defensive attitude" [4] and
- crossed hands on the chest is a position that reveals the strength.

When talking about the movements of legs, harmonized are two basic seating positions, which are:

- legs that are commonly crossed may signal nervousness, reserve or defensive position, and
- legs in the 4 figure sitting position (so-called American position) is an attacking nature.

Touch is a complex set of multiple senses, which have special nerve endings in the skin, muscles and elsewhere, and respond to different stimuli and transmit the impressions to the brain for their further processing [5]. Touch communication can cause both positive and negative effects, all depending on people or circumstances. "The meanings that we attach to touch vary depending on which part of the body touches, how long the contact lasts, touch strength, touch mode (...) and more frequent touching" [3].

3. ANALYSIS OF SURVEY ON THE NONVERBAL COMMUNICATION AND BODY LANGUAGE ON EMPLOYEES IN THE ACCOUNTING AGENCY "KAJA"

With the consent of the employee, the survey was conducted in company Accounting agency

"Kaja" based in Slavonski Brod. Accounting agency "Kaja" is a legal form of crafts dealing with other social and personal activities.

"Kaja" exists between 20.1 and 50 years and has up to 25 employees, of which seven have agreed to cooperate and participate in the survey. Two men and five women make up the composition of the survey. Five is aged between 41 and 50 years, and two between 51 and 60 years. All respondents are their secondary education finished in Slavonski Brod, of which six completed economic school and one respondent completed the administrative school. Given the time spent on the labor market and age, all respondents have a working life of over ten years.

After collecting the basic data that generated the image of the company structure and the composition of the employees, they followed issues related to the topic of final work.

3.1. What is for you non-verbal communication?

To the question "What is for you nonverbal communication?", responses were varied as we can see on the graph below.

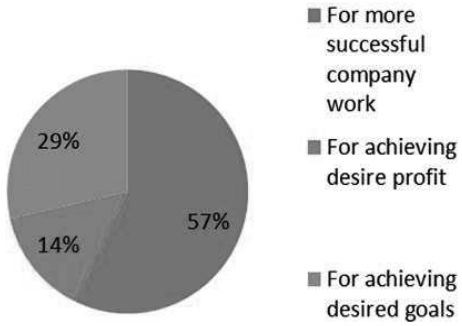

Fig 1. Why is business communication so important?

Two respondents indicated a rough definition of the term and stated that nonverbal communication is a communication with body movements, and one of them supposed that it is the way people communicate without words. Some of the respondents see nonverbal communication as an aid in business collaboration with clients, and they believe that nonverbal communication is an essential factor in business communication. Interestingly, there are also those who do not actually follow the body language of others.

3.2. How much is body language important in communication?

The following graph shows how important body language is in communication.

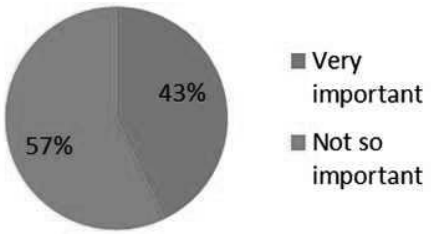

Fig 2. How much is body language important in communication?

The surveyed employees were on this question almost evenly divided. 43% of them think that the body language is very important, and 57% think that their body language in communication is not very important. "Not important" is not a categorical refusal of body language and surveyed probably subconsciously register signals and messages they receive from others.

3.3. How can you improve your body language?

The following graph shows how you can improve your body language.

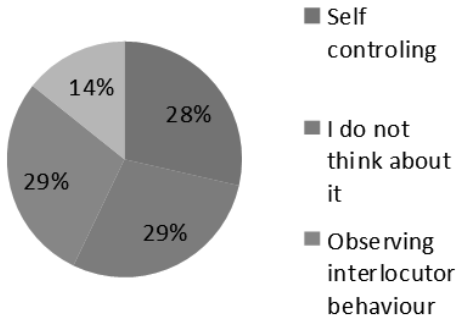

Fig 3. How can you improve your body language?

Some think that the key to improving your own body language is self-control, probably referring to actions interlocutor seeking their reactions. Some say that the exercise is a basis for improving the skills of body language, which really says a lot about how the body language is something that can master and learn.

Another opportunity to improve their own body language is through observation of others, and it states that it is best to monitor the behavior of the interlocutor. If you can read interlocutor's mood, you will be able to adapt your body language to the presentation and thus create a better communication channel.

Finally, there are those who do not even think about the body language and need to improve it.

3.4. Do you think that with body language you can improve much better your business results?

The following graph shows whether employees think that body language can improve the company's success.

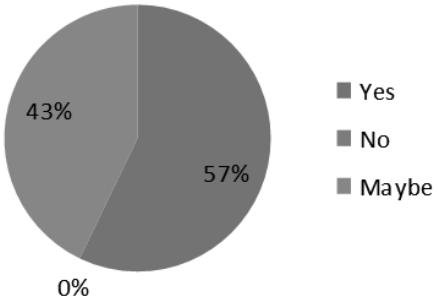

Fig. 4. Do you think that with body language you can improve much better your business results?

Most employees are on the question “Do you think that with body language you can improve much better business results?” answered "Yes", while the rest was a little more cautious and answered "maybe." Employees are aware that the oral presentation of their goods and services are only partially effective and to achieve better business results, their verbal presentation must be complemented by appropriate and adapted to body language. Only an appropriate body of speech will leave the impression of a serious and quality service provider.

3.5. Mark on scale appropriateness certain actions speaker between 1 and 5

The following graph shows the appropriateness of certain actions of the interlocutor.

At first, employees do not have a concrete view of the speaker's forward-facing communication, the uneven tone of voice, or the serious expression of the face because such actions cannot be evaluated outside the context. For example, it is possible that a person with the uneven tone of voice is just a cold and cannot normally talk. There are, of course, people who always have a serious facial expression, but that does not mean they are happy or no happy. That is why such things are difficult to evaluate out of context.

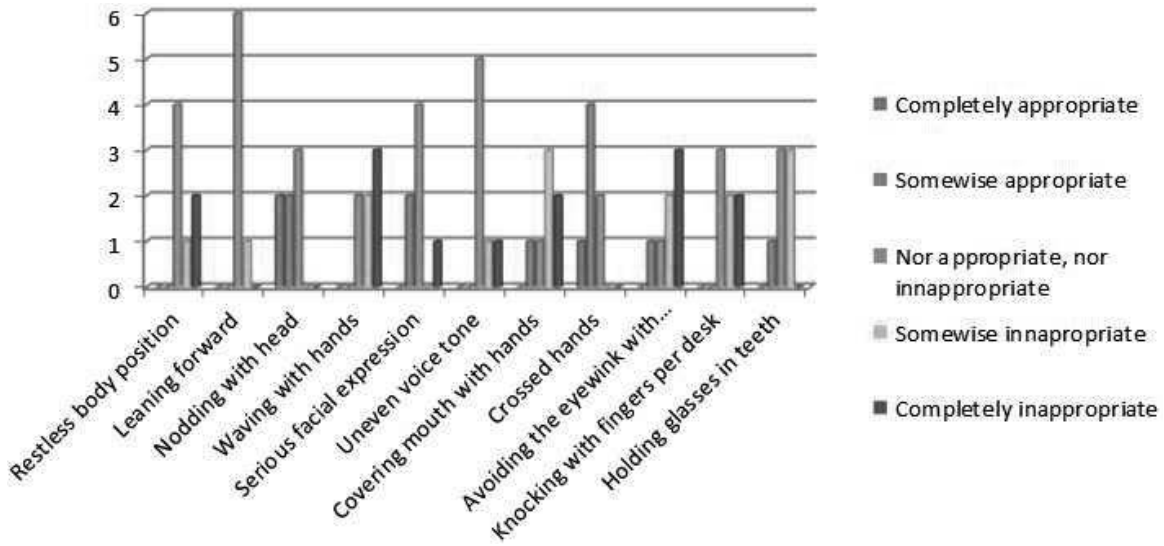

Fig. 5. Mark on scale appropriateness certain actions speaker between 1 and 5 (where 1 means totally appropriate, means totally inappropriate)

Uneasy posture, shaking hands, covering the mouth with the palm, tapping his fingers on the table and avoiding views interlocutor, have negative emotions in the respondents and they evaluate such behavior as inadequate.

Employees see crossed hands and nod the head as an appropriate action in communication. Although crossed hands mark the defense and reluctance to continue communication, respondents do not consider it a necessarily negative one because they encounter it in everyday life and are in fact ignored and ignored. Nod the head is certainly a positive reaction that confirms the recipient's status and tells him to listen and appreciate what he presents.

4. CONCLUSIONS

People are able to communicate with each other even if they do not talk. Speech only partially transmits the message you want to send. In order for the message to be transmitted as best as possible, the mood and the tone of the message will be better served by the nonverbal communication and body language, taking into account the situation and context in which it is and the way it wants its message to be understood.

The body language is taught and observed from the moment when a man first time sees the light of day. Touch is the man main stimulus from the environment. By adopting the language and observing people around you, you learn how to apply body language to enrich the message content you transmit. Then you have a tool to communicate the full sense of the word. Nonverbal communication is often used unconsciously, but you can manage to show what you want and think.

Nonverbal communication is a skill, and every skill can be learned and mastered with the exercise. It all depends on what kind of message you want to transmit and in what kind of situation you find when communicate.

The business environment is best to figure out who is well mastered the technique of non-verbal communication. Specifically, it is important that people inspire confidence, that the pleasant interlocutor and that their behavior shows that they care about others with whom they interact. Those should be both superiors and subordinates, colleagues, mutually with each other, people who need products or services from others, or offer and sell them.

As part of the work is carried out a survey which aimed at a specific example to show what role has the body language in everyday human relations. The answer is; very important role. People are unconsciously reacting to the negative emotions of the interviewer, and then they are negatively evaluated. Likewise, positive presentations are evaluated positively.

Body language and nonverbal communication is something that you really need to pay attention to and study the nuances that they manage and lead the flow of communication. Only then an individual can learn how to behave in a conversation about a job, how to achieve a good relationship with superiors or subordinates, how to behave and deal with clients or associates. Then the business environment will not be a source of stress because of the misinformation of moods, attitudes, or messages.

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The Effect of a Football Treatment on Morphological Characteristics of Football Players NK „Otočac"

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Abstract

There are a number of factors that affect the performance of football players. One of the factors is certainly morphological features. Football is probably one of the most popular and widespread sports in the world and it can be said that so far a lot of researches have been carried out on football players as well as those whose aim was to determine the morphological characteristics of football players. It is already known that a greater amount of muscle mass produces more force that an athlete needs for successful action in sports. Unlike muscle mass, excess ballast has an opposite effect (reduces running speed, decreases explosive power, aerobic and anaerobic endurance). The main problem of this research is the analyses of changes in morphological characteristics of amateur senior football players under the influence of a programmed football treatment. The testing was conducted on 19 examinees of amateur senior football players of NK „Otočac". They trained regularly 5 – 6 times a week and played competitive matches once a week according to football treatment through six micro cycles during the preparatory period. The examinees underwent five tests, two times in a period of 6 weeks. The results of the research show that specially designed and programmed football treatment can significantly affect the morphological characteristics of amateur senior football players.

Keywords: football treatment, morphological characteristics, amateur senior players

1. INTRODUCTION

There are a number of factors that affect the performance of football players. One of the factors is certainly morphological features. Optimal morphological characteristics of athletes are largely dependent on the type of sport, but generally better results are achieved by those whose body is adapted to the requirements of a particular sport [1]. The need for this adaptation is more pronounced in the athlete at a higher competitive level, but also does not diminish for the athlete at a lower competitive level. Football is probably one of the most popular and widespread sports in the world, and it can be said that so far many research have been carried out on football players and so the those whose aim was to determine the morphological characteristics of football players. It belongs to the group of half structural motions which means that complex structures of cyclic and acyclic movements dominate, and are made of complexes of simple and complex movements in the conditions of co-operation of members of the sports team during the match. According to Bangsbou et al. (2003) a very high level of physical ability development

is required: optimal physique, aerobic and anaerobic system development, high muscle strength level, highly developed speed and agility, optimum flexibility and balance. It is already known that a greater amount of muscle mass produces more force that an athlete needs for successful action in sports. Unlike muscle mass, excess ballast has an opposite effect (reduces running speed, decreases explosive power, aerobic and anaerobic endurance). For this reason, methods for determining body composition are needed in order to make the athlete ideal for earning maximum achievement [3]. The main problem of this research is the analyses of changes in morphological characteristics of amateur senior football players under the influence of a programmed football treatment. The basic hypothesis can be defined in the following manner: H1 – Specially programmed football treatment will significantly affect the changes in the morphological characteristics of amateur senior football players.

2. METHODS AND MATERIALS USED FOR RESEARCH

2.1. Examinee sample

The samples of examinees represent 19 examinees of the amateur ranking seniors of NK "Otočac", with an average chronological age of 25.05 + 6.20 years. They trained according to the football treatment through six micro cycles during the preparatory period.

2.2. Variable sample

The examinees underwent five tests, two times in a period of 6 weeks. Their body weight, percentage of fat tissue, percentage of visceral fat, body mass index and percentage of muscle tissue were assessed. The selected morphological characteristics were measured by anthrop meters and diagnostic scales Omron BF 510. The Omron model BF-510 is a tool that evaluates the percentage of fat tissue using bioelectric impedance. Muscles, blood vessels and the internal organs are composed of tissues in which a large amount is found water that easily supplies electricity. Body fat is a tissue that has low electric conductivity. The BF-510 sends a very low voltage electrical circuit to the body (50 kHz) and less than 500μA for the purpose of determining the amount of fat tissue. The flow of these characteristics does not feel the body or feel during the application. Resistance to the movement of electric current through the body, body height, body weight, age and gender are data based on which the following values are calculated.

Body height (ABH): It is measured by an anthrop meter. A football player stands on a flat surface with a weight equally spaced on both legs. The arms are relaxed, the heels are gathered and the head is placed in the so-called Frankfort horizontal position, which means that an imaginary line that connects the lower edge of the left orbit and the left ear helix is in the horizontal position. The horizontal arm of the anthrop meter is dropped down to the head (vertex point) so that it clings firmly but without pressure.

Body weight (ABW): It is measured by digital scales. Before the start of the measurement scale is set in the prime position. The football player is standing upright in the absence of a shoe.

Measurement of BMI: To calculate BMI measure, the OMRON BF 510 uses the figure for the body height that is entered in personal profile or when you entered measurement data in Guest Mode. If the level of fat tissue that has been shown by BMI is higher than the international standard, there is a higher possibility of susceptibility to common obesity diseases

Measurement of the percentage of fat tissue (AFT): The percentage of fat tissue refers to the amount of body fat in relation to the total body mass expressed in percentage. OMRON BF 510 uses a bio impendence method to estimate the percentage of fat tissue in your body. Depending on where this fat tissue is distributed in the body, it is classified as visceral fat or subcutaneous fat.

Measurement of visceral fat tissue level (AVF): Visceral fat tissue is fat that surrounds the internal organs If a person has too much visceral fat tissue, it is considered to be closely related to increased level of fat in the bloodstream, which is a condition that can lead to serious disorders and diseases such as hyperlipidemia and diabetes that endanger the ability of insulin to transfer energy from the bloodstream for the use in cells.

Subcutaneous fat tissue (AFT): Subcutaneous fat tissue is accumulated not only around the stomach, but also around the upper arm, hips and thighs, and can cause distortion of body proportions. Although it is not directly related to an increased risk of diseases, it is thought it increases heart pressure and causes complications and difficulties. Subcutaneous fat is not displayed on this device, but it is included in the percentage of fat tissue that this device expresses.

Skeletal muscles (AMT): Muscles are divided into two types: muscles in the internal organs, such as the heart, and skeletal muscles that are linked to the bones and are used to trigger the body. Skeletal muscles (chest muscle tissue) can be increased by exercising and by other activities. Increasing the proportion of skeletal muscles means that the body can easily burn energy, which means it is less susceptible to fat tissue precipitation, which makes the assumption of an energetic way of life. The paper should be prepared according to the requirements provided in Table 1. Please pay attention to the fact that the subsection should be not shorter than a half of the column.

2.3. Experimental plan and program

The testing was conducted on a 19 examinees of amateur senior football players of NK „Otočac“. They trained regularly 5 – 6 times a week and play friendly matches once a week according to football treatment through six micro cycles during the preparatory period. Their body weight, percentage of fat tissue, percentage of visceral fat, body mass index and percentage of muscle tissue were assessed. In tables 1 to 3 one may see example of micro cycles.

Table 1. Example of introductory micro cycle

Monday	Dynamic stretching + stabilization exercise -20 ', aerobic endurance of low intensity through auxiliary play - 40', play at 2 goals 11:11 - 15 ', static stretching 10'
Tuesday	Dynamic stretching + body stabilization exercises and proprioception - 25 ', aerobic endurance of medium intensity - 30', play at 2 goals 11:11 - 20 ', relaxation exercises + static stretching - 15'
Wednesday	Dynamic stretching + body stabilization exercises and proprioception - 25 ', circuit training of repetitive strength - 45', relaxation exercises + static stretching - 15 '
Thursday	Day off
Friday	Dynamic stretching + body stabilization exercises and proprioception + speed exercises 30 ', aerobic endurance of medium intensity - 30', play at 2 goals 11:11 - 10 ', strength toning exercises - 5'
Saturday	Friendly match
Sunday	Day off

Table 2. Example of a specific micro cycle

Monday	Dynamic stretching + body stabilization exercises -20 ', anaerobic (g) endurance through technical-tactical training (transition defense-offence) - 45' (small sided games), play at 2 goals 11:11 - 15 ', relaxation exercises and static stretching - 15 '
Tuesday	Dynamic stretching + body stabilization exercise and proprioception + speed exercises-30 exercise, technical-tactical training (attack phase) - 25 ', play at 2 goals 11:11 - 10', speed toning exercises -5 '
Wednesday	Friendly match
Thursday	Dynamic stretching -15 ', low intensity aerobic training - 15', static stretching - 15 '
Friday	Dynamic stretching + body stabilization exercises + speed exercises -30 ', anaerobic (g) endurance through technical-tactical training (transition offence-defense) -35' (small sided games), play at 2 goals 11:11 - 10 ', relaxation exercises and static stretching - 15
Saturday	Friendly match
Sunday	Day off

Table 3. Example of a situational micro cycle

Monday	Dynamic stretching + stabilization exercise - 20 ', aerobic training of high intensity (small sided games) - 25', technical-tactical (situational) training - 25 ', static stretching - 10'
Tuesday	Dynamic stretching + body stabilization exercises + speed exercises -30 ', speed and agility training (intervals 5 "-10") -25', technical-tactical training (attack phase) - 20 ', relaxation exercises and static stretching - 15'
Wednesday	Dynamic stretching - 15 ', training match - 60', relaxation exercises and static stretching - 15 '
Thursday	Day off
Friday	Dynamic stretching + body stabilization exercises + speed exercises -30 ', speed and agility training (intervals 5 "-10") -25', technical-tactical training (attack phase) - 20 ', speed toning exercises 5'
Saturday	Friendly match
Sunday	Day off

2.4. Methods of data processing

The data collected by initial and final testing of football players have been analyzed by basic statistical procedures: arithmetic mean, standard deviation, minimum value, maximum value, asymmetry degree and curvature degree. Normality distribution is tested by KS test. The differences between morphological characteristics in the initial and final testing were determined using the T-test for dependent samples. Antropometar and diagnostic scales Omron BF 510 measured the selected morphological characteristics.

3. RESULTS THROUGH DISCUSSION

Basic statistical parameters were calculated with the use of descriptive statistics and the results are shown in the Table 4. Descriptive parameters are calculated on initial results and final results. The basic descriptive statistical parameters show that all variables are normally distributed and that there is no extreme data scattering which is important for the upcoming statistical processing. It can be noticed that the average values of the results in all the tests, obtained in the final measurement, have been improved in relation to the values of the initial measurement results, which is in line with the expectations. Also, the parameters of the minimum and maximum results show that the range of results obtained in the final measurement is smaller than the values of the initial measurement results. The standard deviation values are greater in the initial test than in the final. The measure of asymmetry show the values close to zero in all the variables, which tell us that the dispersion of footballers' results is symmetrically distributed. As far as the curvature is concerned, most variables are

platicurtic ones, which tells us about the great variety of football players under consideration. The results from the final testing have shown how a programmed treatment with the appropriate training process can affect the morphological characteristics of amateur senior football players.

Table 4. Descriptive indicators of measuring variables – initial and final testing

	N	AS	Min	Max	SD	Skew	Kurt
AGE	19	25,05	18,00	39,00	6,20	1,04	0,22
ABH	19	181,84	172,00	188,00	5,12	-0,69	-0,60
ABW-I	19	85,21	69,00	96,00	7,44	-0,88	0,38
BMI-I	19	25,76	22,00	27,80	1,53	-1,05	0,70
AFT-I	19	21,04	14,00	26,20	3,78	-0,28	-1,03
AMT-I	19	38,68	35,30	43,70	2,38	0,59	-0,21
AVF-I	19	7,53	4,00	11,00	1,78	-0,05	0,08
ABW-F	19	83,42	70,00	91,00	6,04	-0,88	0,03
BMI-F	19	25,20	23,10	26,90	1,10	-0,67	0,09
AFT-F	19	19,75	15,20	24,70	2,79	-0,05	-1,05
AMT-F	19	39,78	36,90	43,30	1,70	0,44	0,00
AVF-F	19	6,58	5,00	9,00	1,17	0,72	0,26

AS–arithmetic means, **SD**–standard deviation, **Min**–minimum value, **Max**–maximum value, **Skew**–asymmetry degree, **Kurt**– curvature degree

The differences between morphological characteristics in the initial and final testing were determined using the T-test for dependent samples to verify the existence of statistically significant differences in the measurement variables. The results are shown in Table 5.

Table 5. The differences between morphological characteristics in the initial and final testing

	AS	SD	N	t	df	p
ABW-I	85,21	7,44				
ABW-F	83,42	6,04	19	3,98	18	0,0009
BMI-I	25,76	1,53				
BMI-F	25,20	1,10	19	4,19	18	0,0006
AFT-I	21,04	3,78				
AFT-F	19,75	2,79	19	3,40	18	0,0032
AMT-I	38,68	2,38				
AMT-F	39,78	1,70	19	-4,32	18	0,0004
AVF-I	7,53	1,78				
AVF-F	6,58	1,17	19	3,66	18	0,0018

AS–arithmetic means, **SD**–standard deviation, **N**-number of Participants**, df**-degrees of freedom**, p**-statistical significance**, t**-value of t-test

According to the results given, there is a significant difference in all observed variables between the measured results under the influence of programmed football treatment on the morphological traits of the footballers of NK "Otočac" and we fully accept the H_1 hypothesis. It can be said that a specially programmed football treatment can significantly affect the changes in the morphological traits of amateur senior footballers.

The highest t-test value is for the variable the difference in the percentage of muscle tissue

difference which is -4.32 with 18 degrees of freedom and subcutaneous fat 4.19 with 18 degrees of freedom and significance level p = 0.00. The lowest value of the t-test is for the variable the percentage of visceral fat which is 3.66 with 18 degrees of freedom and the significance level p = 0.00. These results are in line with the expectations. In this way we can indirectly affect one of the factors, morphological features which influence the performance of football players. As already being mentioned in the text for the success of a football player the optimal physical body is also needed, which by the influence of the programmed football treatment can be affected at this level?

4. CONCLUSIONS

The main goal of the research is to analyses the changes in morphological characteristics of amateur senior football players under the influence of a programmed football treatment. The testing was conducted on a 19 examinees of amateur senior football players of NK „Otočac“. They trained regularly 5 – 6 times a week and play competitive matches once a week according to football treatment through six micro cycles during the preparatory period. Their body weight, percentage of fat tissue, percentage of visceral fat, body mass index and percentage of muscle tissue were assessed. The results of the research show that specially designed and programmed football treatment can significantly affect the morphological characteristics of amateur senior football players.

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Employers' Perspective on Employability Skills of Croatian Engineering Graduates

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Abstract

Recent developments in work arrangements and a rapid growth in technological innovation constantly challenge engineering education to transform itself and to meet demands of engineering practice. Among different stakeholders these demands are covered in terms of employability skills and competences engineers need in contemporary working arrangements. This paper aims to explore to what extent the current academically driven set of engineering skills fits the expectations of Croatian employers. Referencing corresponding research worldwide, a number of important skills were included in the questionnaire administrated to Croatian employers. A total of 418 respondents participated in the questionnaire, mainly coming from the private sector (360). In accordance with the results of other research it was found that Croatian employers prefer mostly the so called transferable skills such as professionalism and responsibility, teamwork and lifelong learning. Some important differences in skills ratings were found with regard to respondents' gender and according to the type of organisation's ownership. Since transferable skills are still underrepresented at Croatian academic engineering study programs, these results make clear guideline in the process of further alignment of engineering education with the needs of labour market.

Keywords: engineering, skills, learning outcomes, employers

1. INTRODUCTION

Over the past 30 years engineering embraced not only the promise of a rapid technological development and information era but has also faced new challenges of engineering practice and contemporary work arrangements [1]. While the technological development since 1990s helped to promote engineering as a vital branch of economic growth in economies around the World, placing the Science, Technology, Engineering and Math field (STEM) in the centre of political agenda, work arrangements for many engineers proved to be double faced: promising and, at the same time, often short-termed and precarious [2].

Additionally, it turned out that the extent of jobs for engineers has widened dramatically, with possibilities for employment in non-traditional engineering areas of work, primarily in the financial sector, but also in different parts of the service sector where analytical skills have become increasingly important [3]. These new developments also influenced the public image of engineering in general and of their nature of work.

The engineering community has responded to these social, economic and technological changes with the promotion of new skills which should be more strongly embedded in their education and would support new graduates to establish themselves as legitimate actors in the "brave new world of work" [4], ie., as reliable professionals and experts, dedicated to high ethical standards, creative, open to new kinds of knowledge and, most importantly, employable in a wide range of jobs and employment circumstances [5].

Focus on new skills and competencies has been clearly specified in documents of international engineering associations as well as in recommendations of accrediting bodies for academic engineering education. For example, the National Academy of Engineering (NAE) took into account that engineering education should include content which could advance career opportunities for new graduates in traditionally non-engineering jobs [6]. More precisely, NAE specified a number of skills engineers will need in 2020 where traditional analytical skills maintained its lasting value but more than ever before were coupled by creativity, ingenuity and so called transferable skills.

Similarly, the Accreditation Board for Engineering and Technology (ABET) established EC2000 Criterion 3 as a frame of reference for engineering studies worldwide, where among 11 student learning outcomes so called transferable skills like professionalism, leadership, communication skills, ethics and ability to understand the contemporary social and cultural context has taken a significant part [7].

In corresponding scientific literature these new skills and learning outcomes were indicated as employability skills. A number of research all over the world has been conducted to assess different stakeholders' viewpoints on outcomes with employers' expectations as the most frequently explored in this regard.

Some research results are available for fast growing economies where the STEM field has been taken as important for a national economic and technological development. Blom and Saeki, for example, indicated that the Indian economy still has to balance its increasing need for engineers with the quality of skills Indian employers needed [8]. Similarly, Zaharim et al. have provided a framework for Malaysian engineering programmes with engineering employability skills based on comparative study of engineering skills and attributes required by different accreditation bodies in several countries around the World [9]. Corresponding research has been made in the most developed economies like Australia, USA, and GB. In the Australian context, Hagan has found that 40% of employers were not satisfied with the level of ICT students' proficiency in generic skills [10]. In Britain, Markes has made a systematic literature review showing that British employers perceive transferable skills among the most important engineering skills in contemporary firms [11].

Almost all of these studies methodologically refer to the set of engineering skills indicated in ABET EC2000 Criterion 3. Considering its wide methodological usage, Strauss and Terenzini developed a psychometrically sound instrument for assessing employers' viewpoints on engineering learning outcomes [12] which resulted in a nine factor solution representing the main engineering skills. Strauss and Terenzini's study has served as a guiding point for in conceptualizing the questionnaire for Croatian employers.

Since the reform of engineering study programs in Croatia is still predominantly internally driven, determined by academic evaluations, and followed with just a few initial researches [13-14], our primary research objective was to discern whether the prevailing learning outcomes in engineering study programs in Croatia meet the expectations of Croatian employers. Additionally, possible differences in employers' ratings of preferable engineering skills were studied through comparison of a number of independent variables like employers' field of activity, enterprise size, type of ownership and respondents' gender.

2. SAMPLE AND METHOD

Assuming that employers aren't keen on participating in studies an oversampling of employers has been made using both the register of Croatian's Chamber of Commerce [15] and the archive of the Faculty of Mechanical Engineering and Naval Architecture (FAMENA) [16] "job openings and scholarships" column. As the Chamber of Commerce's archive lists every legal entity in Croatia, only active entities which had delivered their financial report for 2015 were selected in order to reach a, not only sufficient, but also efficient sample.

Companies have been sorted by their annual income in descending order, and categorized by

the number of employees into big (>250), medium (50-249), small (10-49), and micro (1-9). With category size yielding no more than 250 employers in each category of the National Classification of Occupation [17] the total number of unique contacts was 7586. Adding to it FAMENA's contacts, as well as asking the respondents to snowball the interview link resulted in a final total of 8878 recipients.

2.1. Data analysis

SPSS 22 software was used in order to statistically analyse data. Mean differences (one sample t-test, t-tests of independent samples, and ANOVA) were tested at $p<.05$ significance, with ANOVA employing Bonferroni's test when equal variances were assumed, and Tamhane's T2 test when equal variances were not assumed.

2.2. Sample's profile

Out of the total of 418 respondents, a vast majority came from the private sector (360) while 56 respondents were from government linked companies and only 2 from NGO's. Based on their size, 88 companies were micro, 169 small, 104 medium, and 57 big, with the majority of them coming from economic branches such as manufacturing (78), construction (70), ICT (46), and professional, scientific, and technical activities (33). The majority of these organizations employed engineers as in-house professionals (329), 27 outsourced them, while 62 of them used a combination of the two.

Respondents' positions within the organization were mainly those of directors, owners or members of the supervisory board (223), HR managers or employees (68), managers of other departments (94) or other (33) with 279 respondents being male, and 127 female.

Mechanical engineers (197) were the most sought up professions, with computer engineers (63), construction engineers (46), and electrical engineers (30) following.

Finally, in order to emphasize the importance of gathered responses, respondents which didn't partake in an employment process in the last five years (69) were excluded from further analysis, which brought the total sample to 349.

3. RESULTS AND ACHIEVEMENTS

Even though the scale was originally 5 point, after eliminating the middle value, 4 points were retained, namely: "1 – not at all important", "2 – somewhat unimportant", "3 – somewhat important", and "4 – extremely important". Of the 36 items, only one came close to being rated as somewhat unimportant (General knowledge about national and international events – $\bar{x}$ 2.48), while 17 were rated as extremely important, and 18 as somewhat important (Table 1).

Apart from the mean values being extremely positively skewed, the overall standard deviation of scores is low. Every item has a SD lower than 1, and the 9 highest items sorted by means have an SD lower than 0.5, indicating not only that employers want engineers who "have it all", but that all these skills are treated as equally "extremely important" regardless of the economic branch the organization conducts its business in, its size, the specialists it employs or its governmental/private/NGO ownership. Since it would be of no significance to simply list all the researched skills as valuable to employers, a more extreme approach is undertaken while interpreting data.

Professionalism, portrayed by the ability to work under pressure and follow directions while staying motivated, conscientious, and respecting deadlines, is found vastly important. Respondents want their employees to excel at *problem solving* as well, which comes as no surprise with engineers enjoying a reputation of fixers and tinkerers. Such problem solving skills include the ability to identify and define problems independently, design practical solutions to fix them as well as being capable of approaching the problem from different angles.

In contrast, skills linked to *designing experiments*, *data analysis* and *specialization*

were rated statistically significantly lower than all problem solving items, which leads to the conclusion that employers seek engineers who are “jacks-of-all-trades” and have innovative designs rather than specialists in specific fields who are “wasting time and money” on R&D. That cream-of-the-crop approach seems to lead employers’ thinking in other dimensions too.

Although *teamwork* is found extremely valuable, employers favour abilities of working in interdisciplinary teams, coming to optimal solutions and understanding one’s role statistically higher than emotion management, empathy and abilities to lead teams. Likewise, *project management* skills are rated only somewhat important with the highest ranked being the ability to write technical documentation, while abilities to think strategically and design quality management systems seem to be less of a concern.

Communication skills are regarded as extremely favourable in terms of abilities to express oneself and to convey ideas and solutions to a non-professional public, but the ability to negotiate is regarded as a significantly less favourable trait.

Items measuring ethics and responsibility are ranked relatively low, with the exception being the ability to follow and implement rules of the profession, perhaps because of its connection to the concept of professionalism.

Specific skills are rated moderately high, with the ability to use and implement specific tools, skills and techniques being seen as an extremely important skill, while the ability to use advanced computer software and the ability to recognize interactions between elements in technical systems are rated significantly lower, perhaps because of their link with other domains (experimenting and project leading one).

Finally, items defining the domain Other sank to the bottom of the importance scale, with the exception being an ability to understand a foreign professional language and, to some extent, a practical experience during formal education. Low scores on other items perhaps accentuate the wants of employers to employ engineers as “doers” and not “thinkers” and shed some additional doubt on the social acceptability quality of ethic and responsibility answers.

3.1. Further analysis

In order to further explore possible differences in skill appreciation between employers, t-test and ANOVA analyses were applied based on independent variables such as respondent’s gender, their positions within the organizations, the specialists they employ, as well as the economic field, and their total number of employees. While the majority of tested variables showed just a few statistically significant differences, respondents do seem to value skills very differently based on their gender and slightly differently based on the organizations’ ownership.

Generally speaking, women tend to value all measured skills more than men, with a mean of 3.5 compared to the 3.3 of their counterparts, and with 26 out of 36 skills being statistically significantly higher, which makes them somewhat harder to impress during the hiring process. Specifically, women value all of the items comprising the Communication skills, Experimentation, Ethics, and Project management dimensions, as well as all apart one from those of Professionalism and Problem solving (“Ability to work under pressure” for the former, and "Design of practical solutions“ for the latter).

Although just a few skills rated significantly different when compared on the available ownership categories, their domain setup showed an interesting, and perhaps expected difference between respondents from government-owned and private owned organizations with the former valuing items comprising the Ethics and responsibility domain significantly higher than the latter, with the item “Conscientiousness and ability to implement rules of the profession” being the exception.

Table 1. Mean and standard deviation values of items operationalizing engineer skills

Item	N	$\bar{x}$	SD
Professional and conscientious approach to work tasks	317	3.9	0.35
Willingness for lifelong learning of engineering knowledge, skills and techniques	326	3.8	0.47
Motivated approach to work tasks	321	3.8	0.44
Conscientiousness and ability to implement rules of the profession	324	3.7	0.44
Ability to respect deadlines	318	3.7	0.44
Ability to come to an optimal solution while working with others	320	3.7	0.5
Ability to independently identify and define problems that need solving	322	3.7	0.49
Understanding and respecting one's and others' role in teamwork	327	3.7	0.49
Ability to find different solutions for existing problems	321	3.7	0.48
Concise and clear communication of ideas to non-engineers (public, clients...)	332	3.6	0.55
An active interest in engineering technology, knowledge, skills and techniques	322	3.6	0.53
Design solution to meet desired needs	322	3.6	0.57
Ability to communicate and express oneself clearly	331	3.6	0.53
Ability to work under pressure (deadlines, downsizings, demanding clients...)	319	3.6	0.58
Ability to choose and use specific engineering tools, skills and techniques	314	3.6	0.57
Ability to work well in interdisciplinary teams	327	3.5	0.61
Ability to follow directions when working on tasks	320	3.5	0.57
Understanding a foreign professional language	312	3.4	0.66
Ability to lead teams	324	3.4	0.64
Ability to write technical documentation	315	3.4	0.68
Ability to use advanced computer software	316	3.4	0.66
Ability to negotiate with clients and employers	326	3.4	0.73
Putting ethical standards at the foremost place when working on tasks	320	3.3	0.68
Ability to manage one's and recognizing others' emotions	326	3.3	0.63
Taking into account societal and environmental repercussions when designing solutions	319	3.3	0.65
Specialization in an engineering field	321	3.3	0.69
Ability to think, plan and lead projects strategically	317	3.2	0.66
Practical experience during formal education	314	3.2	0.78
Ability to recognize interactions between elements in technical systems and processes	311	3.2	0.69
Ability to design and lead experiments in order to test new technical solutions	323	3.1	0.79
Ability to design processes of quality management	314	3.1	0.7
Ability to analyze and interpret experiment results	323	2.9	0.83
Understanding the global repercussions of engineering solutions	305	2.7	0.78
Advanced understanding of mathematics	305	2.7	0.78
Understanding contemporary (economic, ecological, political...) problems	311	2.6	0.76
General knowledge about national and international events	306	2.5	0.84

4. DISCUSSION

Croatian employers value most of the learning outcomes suggested by the questionnaire highly. However, their ratings aren’t quite consistent. This is most visible in the case of so called specific engineering skills like problem solving, experimentation and IT skills where values differ significantly among Croatian employers. Particularly in the differences on the "ability to independently identify and define problems that need solving" (one of the most valued learning outcomes) and the "ability to analyse and interpret experiment results" which seems to be relatively poorly valued by Croatian employers. Additionally, none of these specific engineering skills are among the top three learning outcomes. It seems that Croatian employers are either not worried about specific technical learning outcomes in Croatian engineering study programs or expect

these outcomes to be raised along the graduates' working experience

On the other hand, transferable skills are undoubtedly extremely important to Croatian employers. For example, the top ranked item ("professional and conscientious approach to work tasks") suggests expectations that could be theorized in terms of professionalism and work ethic [18]. The next five top ranked learning outcomes also belong to a wider set of transferable skills, previously conceptualized in terms of professionalism, lifelong learning, teamwork, ethics and responsibility [18].

However, some inconsistencies regarding the way employers value transferable skills and learning outcomes are notable. Findings suggest that employers approach transferable skills mainly instrumentally and in terms of graduates' potential organisational functioning. More precisely, employers prefer learning outcomes which could habilitate engineering workforce to conscientiously approach work tasks, be highly motivated, strictly adhere to rules of the profession; meet the deadlines; be able to join work teams successfully; and be ready for lifelong learning in different strains of engineering profession.

Other aspects of transferable skills are far less valued by Croatian employers. Although NAE and ABET recommendations have recognized the necessity for engineers to be broadly educated, highly cultured professionals and responsible citizens conscious of their greater role in an ever more technological society, it seems that Croatian employers do not attach great importance to these attributes. For example, items such as "understanding contemporary (economic, ecological, political...) problems" and "general knowledge of national and international events" are the lowest ranked.

Finally, regarding independent variables, it is obvious that employers differ significantly in preferences of learning outcomes according to their gender. Generally, female employers attribute greater value to all skills, both technical and non-technical, than men [18]. Also, women value negotiation skills more, skills which are not highly valued by part of the employers as they could possibly result in harsher promotion raise negotiations. Further, it seems that women value all items measuring ethics and responsibility far more than men do, suggesting that women generally "find ethics important not only in the workplace but in regard to the environment as well" [18]. In sum, employers' gender differences in regard to the perception of engineering skills are evident and significant and have yet to be explored in more detail to allow for more elaborated explanation.

5. CONCLUSION

This research findings not only suggest that employers value transferable skills in the daily work of contemporary engineers, but are also consistent with corresponding research on skills and learning outcomes in engineering education [1, 3, 6, 7]. Considering these and previous results, engineering study programs should open more room for courses dealing with issues such as professional responsibility, ethics in engineering, group processes in work teams and communications.

Finally, our findings indicate women express a more holistic understanding of engineering skills which strongly corresponds to recent demands of engineering skills in contemporary engineering employability literature [8-14]. Since engineering is still a male dominated profession in Croatia, these findings allow for a conclusion that female employers possibly fit more in the future visions of engineering currently established by the most relevant engineering organisations and corresponding engineering education stakeholders.

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Active Labour Market Policy Programs for Young People in the Republic of Croatia

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Abstract

Active Labour Market Policy programs aim to enable unemployed young persons for labour market through the professional training without establishing steady employment. In that way, young people are being trained for their profession and employer gets free working labour because state pays their salary. The subject of this research is to explore trainee's satisfaction with the professional training measure through several variables. Research was conducted among trainees and their mentors. The research was carried through social media (Facebook) and "I worth more" initiative. The aim of this research was to evaluate satisfaction and verify experience of professional training trainee's. In the online research 508 respondents participated of which 465 was female, 43 male and 104 respondents were trainee's mentors. Based on the sample which participated in research we may notice that professional training measure without establishing steady employment requires modifications of certain elements such as the CES control of jobs performed by trainee, increase of compensation amount, the right to sick leave and employers should be conditioned to employ trainees in future. In that way, better satisfaction of trainees would be attained together with better usefulness for CES and companies.

Keywords: professional training, young people, trainee's satisfaction

1. INTRODUCTION

Active Labour Market Policy programs aim to enable unemployed persons for labor market through the professional training without establishing steady employment. In that way young people are being trained for their profession and employer gets free working labour because state pays their salary. The transition of young people from the school to the job needs to be realized through the relation between the employer-education system [1].

The major difficulties that young people face according to the attitudes and thinking of employers are the following (Institute for Labor Market Development, 2012): Young people after graduation are not educated enough for the occupations they have been trained for (71%). Further, there is not enough incentives for youth employment by the state (32%), the young without experience are financially less profitable because they "do not earn" their salary (24%). According to the attitudes and thinking of employers there are next facts found in the research: they cannot get quality young people

through free employment services (16%) [2]. In 2018, measures of active employment policy were presented with the aim of increasing the number of employed person in Croatia and reducing the number of long-term unemployed persons. One of the measures of active employment policy, that is the subject of this research, is the professional training for work without employment. At the beginning of this year (2018) there was a change in this level of employment, the percentage of people that the public sector can receive after vocational training has decreased from 10% to just 3%. [3]

Figure 1 shows the number of users involved in the measure of professional training for work without employment [4]

Fig. 1. Number of users involved in the measure of professional training for work without employment for the period 2011-2017[4]

2. METHODS AND MATERIALS USED FOR RESEARCH

The subject of this research is to explore trainee's satisfaction with the professional training measure through several variables: type of company ownership, type of job, duration of this measure, satisfaction with mentor, will for remaining in the company after training and total satisfaction with professional training measure. The study included 508 participans, of which 465 females, 43 males and 104 mentors. [3]

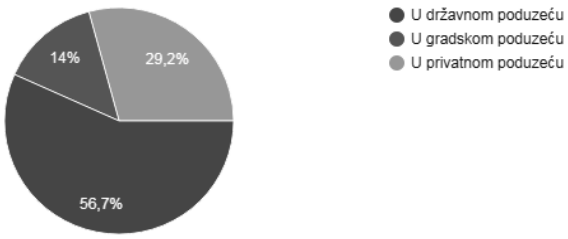

Fig. 2. Type of company ownership [3]

A total of 70.7% of users are professionally trained in state and municipal companies. According to the type of job, on the administrative work is 31.6% of users, work on the ground is performed 2.8% of users, bookkeeping tasks in order to 1.2%, of users, accounting does the 5.6% of users, marketers is 3.4% of users, craftsmen does the 7.4% of users. 48.1% of users are doing something else.

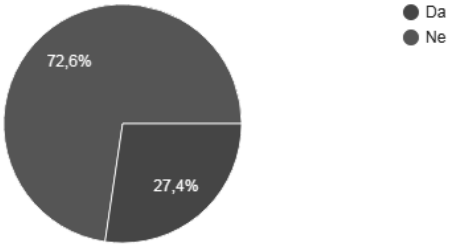

Fig. 3. Satisfaction with the professional training measure without establishing steady employment [3]

According to the results 72,6% of respondents are not satisfied with the professional training measure without establishing steady employment.

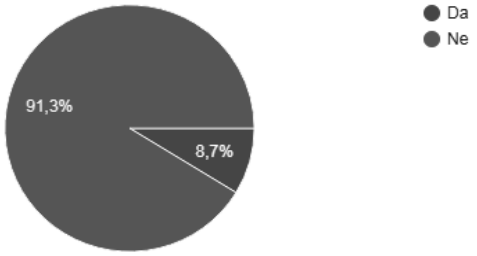

Fig. 4. Satisfaction with salary [3]

8.7% of respondents said they were satisfied with the salary, while 91.3% answered that they were not satisfied with the salary.

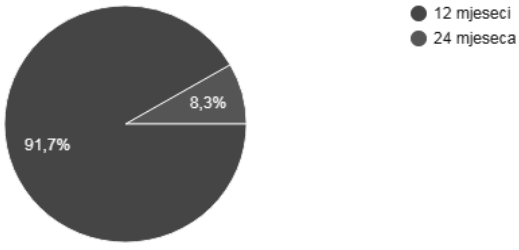

Fig. 5. Duration of training [3]

91.7% of users were in training 12 months.

With mentor are satisfied 56,4% while rest of trainees (43,6%) are not satisfied with their mentor. One of the most frequent reasons why

they are not satisfied with mentor is: mentor is too busy (37,6 %), unprofessional (10,2 %) or indifferent (37,2 %).

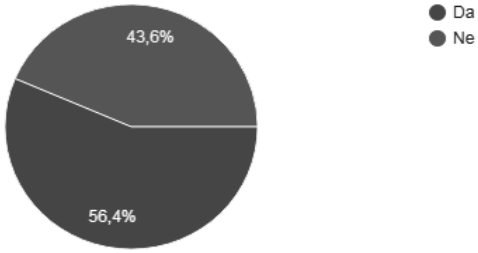

Fig. 6. Satisfaction with mentor care [3]

Why they are not satisfied with mentor is: mentor is too busy, unprofessional or indifferent. Totally 74,7% trainees would like to stay working in the company after finishing their professional training. Regarding mentors 87,5% of them are not getting any remuneration for mentorship, 62,4% regards that they are devoting enough time for mentorship and 89% consider that trainees are interested in learning.

One of the difficulties for the participants, especially those who have health problems or needs more free days than they can take advantage of, is that if they are going to sick leave they cannot be on sick leave for more than 30 days in continuity. After passing these 30 immediately following the cancellation of the contract. [3]

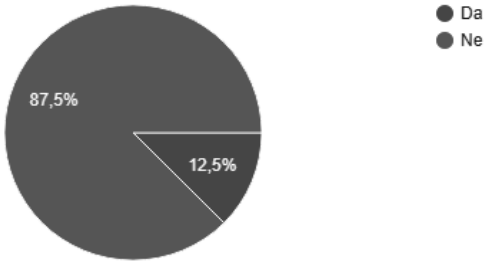

Fig. 7. Remuneration for mentorship [3]

Regarding mentors 87,5% of them are not getting any remuneration for mentorship.

37.6% of mentors believe they do not devote enough time to the participants. They replied that they have too much work, that are not adequately paid and they are not interested. These are the three most common reasons for their dissatisfaction. 89% of mentors consider that trainees are interested in learning.

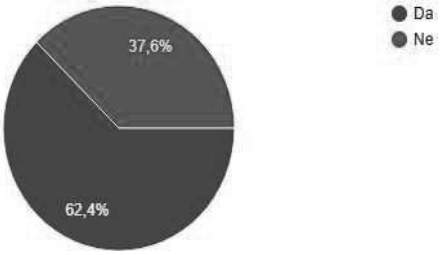

Fig. 8. Whether the mentor devotes enough time to the attendants (mentor's opinion) [3]

3. CONCLUSIONS

The measure of professional training for work without establishing employment is designed to help young people gain first-time job experience and to encourage employers, mostly from the private sector, to recruit young people.

The aim of these measures was that the state help employers by taking the cost of young workers during their training or to them by employers thereafter retain the company as permanent employees. A very small percentage of young people have come to this goal. Many young people this measure are greeted with optimism and later with a great deal of disappointment. They were given the opportunity to acquire certain work experience in the job for which they were educated. On the other hand, they are disappointed by the attitude of the legislator because during professional training they do not have workers' rights as "real" workers of these companies, such as the right to sick leave. According to the results 72,6% of respondents are not satisfied with the professional training measure without establishing steady employment. As the most common reason trainees are mentioning low compensation, amount and impression that they will not benefit from this measure in future employment process. Totally 56,7% trainees are being professionally trained in company owned by state, of which 91,7% in 12 months system and 91,3% is not satisfied with compensation amount. With mentor are satisfied 56,4% while rest of trainees (43,6%) are not satisfied with their mentor. One of the most frequent reasons why they are not satisfied with mentor is:

mentor is too busy, unprofessional or indifferent. Totally 74,7% trainees would like to stay working in the company after finishing their professional training. Regarding mentors 87,5% of them are not getting any remuneration for mentorship, 62,4% regards that they are devoting enough time for mentorship and 89% consider that trainees are interested in learning. Based on the sample which participated in research we may notice that professional training measure without establishing steady employment requires modifications of certain elements such as the CES control of jobs performed by trainee, increase of compensation amount, the right to sick leave and employers should be conditioned to employ trainees in future. In that way, better satisfaction of trainees would be attained together with better usefulness for CES and companies.

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Experiments with a Randomized Method for Probability Maximization

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Abstract

We solve probability maximization problem by inner approximation. The method of the solution is analogous to the classical method of the p-efficient points, but we approximate the epigraph instead of the level sets of the probabilistic function. We experimented with controlling the accuracy in a randomized method.

Keywords: stochastic programming, probabilistic constraints, probability maximization

1. INTRODUCTION

The evolution of infocommunication technologies, such as smart grid and transport systems, requires the development of methods to manage probabilistic constraints.

We deal with two kinds of problems. On the one hand, by maximizing probability in the following form $\max \mathrm{P}(Tx \geq \xi)$ subject to $Ax \leq b$. On the other hand, handle the probability constraint in the following form $\min c^T x$ subject to $\mathrm{P}(Tx \geq \xi) \geq p$ and $Ax \leq b$.

In this problem vector x is the vector which contains the decision variables, A and T are matrices, b and c are vectors with appropriate sizes. The probability p is given ($0 < p < 1$) and the distribution of the random vector ξ is known. It is assumed that the joint distribution function $F(z) = P(z \geq \xi)$ is logconcave therefore the $\Phi(z) = -\log F(z)$ is convex. In the following we are working on this.

The randomized method and the applied procedures are described accurately in the articles [2,3]. In this article we present experiments which we made on the test problems to find the stopping condition.

2. ILLUSTRATING THE METHOD USED

The problem solution consists of two parts. The master problem is a linear programming problem, the searching for an improving column is a unconstrained convex minimization problem. The process is iterative, we are always looking for a new test point where the value of the target function improves most. The method used is a modified variant of Prékopa's dual approach [6], in which we approach the epigraph of the function, not a level set of the function. Unconstrained minimization is done by a gradient method in [3], using a random approximation of the gradient in the randomized procedure in [2]. In [3] we used inner approximation of the probability function Fig. 1. This method is accurate, but very work-intensive. In the article [2] there is developed a random variant of the inner approximation which was used in the [3]. The method is good because if we calculate the gradients imprecisely then we will also give an upper estimate for the function. The test points are not exactly, but we calculate the function values quite accurately. (Fig. 2.).

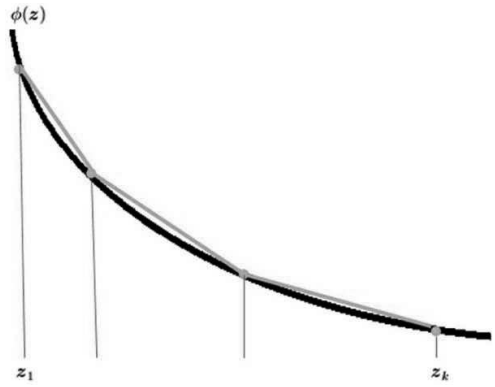

Fig. 1. The inner approximation of the probability function

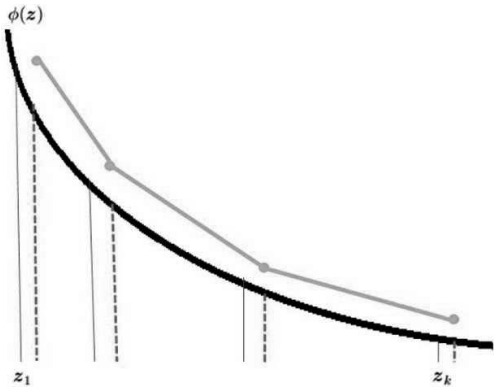

Fig. 2. Approximation of the probability function with randomized method

3. IMPLEMENTATION

We implemented the solution in Matlab. The implementation consists of two parts. The first part is the master problem and the second part is the searching for an improving column. The second part is called oracle in the following discussion.

3.1. The master problem

When we solve this problem we assume a standard normal distribution. Let r be the number of the components of the random vector, which is equal to the number of rows of T matrix. First we look for a suitable starting vector $z_0 \in \mathbb{R}^r$, which is a possible solution of the primary task. This is done by solving the following problem:

$$\max\ t$$

$$1t - Tx \leq 0 \qquad (1)$$

$$Ax \leq b,$$

where $t \in \mathbb{R}$ and $1 \in \mathbb{R}^r$ is a vector of 1 set. If (1) can not be solved, there is no solution to the original problem. On the other hand, if the target value is not limited, 1 probability is available in the original job.

Let $z_0 = 1t^*$, where t^* is an optimal solution of the (1).

Let $Z \subset \mathbb{R}^r$ be a cube with the outside probability weight negligible. Since we work with standard standard distributions, the r dimensional Z cube is considered as symmetric to the origin. In our experiments, we worked with a cube with $P\ (Z)\ \approx 0.995$.

Let $z^{max} = (z_1^{max}, \ldots, z_r^{max})$ be the maximum vertex of the Z cube. In order to facilitate the solution, z_0 additionally initializes the primary task by adding $z_l (l = 1, .., r), z_{r+1}, z_{r+2}$ vectors, where $z_l = (\ z_1^{max}, \ldots, z_{l-1}^{max}, 0, z_{l+1}^{max}, \ldots, z_r^{max})$ are the midpoints of the edges starting from the vertex z^{max} of the Z cube and $z_{r+1} = 0,\ z_{r+2} = z^{max}$. Figure 2. shows these test points.

The master problem was solved with the IBM ILOG CPLEX Optimization Studio for Matlab (12.6.3. version) with tolerance 10^{-8}.

3.2. The oracle

The oracle approximately solves the problem $\max_z\{\overline{u}^T z - \phi\ (z)\}$ in every iteration. We minimize the $\phi(z) - \overline{u}^T z$ function, where $\overline{u}$ is the optimal dual variable of the master problem. The vector z can be imagined as a possible column of the master problem. The optimal solution z^* is the column vector to which the best reduced price belongs in the simplex method.

For each iteration, the function value and gradient vector of the multi-dimensional normal distribution function $F(z)$ must be calculated. For this calculation, see chapter 6.6.4 of the Prékopa book [7]. Using these formulas, the calculation of the gradient of the multidimensional distribution function is simplified to compute the conditional distribution function values. For normal distributions conditional distributions are normal.

The numerical calculation of the multivariate normal distribution values was performed using the QSIMVNV Matlab function implemented by Genz [5].

4. COMPUTATIONS

To test the randomized method, the tasks described in [3] were used for the "cash matching" problem. In the problem that is a normal 15-dimensional problem with normal distribution, some funds must be invested on behalf of a pension fund by making certain payments in the next 15 years. See detailed description in [1,5].

The test problem was originally formulated as cost estimation, with a probability limit. The problem was translated to probability maximize. The right-hand side of the cost constraints is set so that the appropriate optimum probability level is p = 0.9. For these calculations we used the computer code of Szántai [8].

Experiments were conducted to determine the stopping condition by computing the $\mathcal{B}$ described in [4].

$$\overline{\mathcal{B}} = \left(\phi_k(\overline{z}) - \phi(\overline{z})\right) + \max_{z \in Z}\left(\overline{u} - \overline{G}\right)^T (z - \overline{z}) + \Delta \operatorname{diag}(Z)$$

where the different addends represent computation errors in function values and gradients.

The code by Genz [5] applies simulation, therefore sample sizes influence the accuracy. In our experiments we compared iteration numbers and run times needed to decrease $\overline{\mathcal{B}}$ below 0.03.

We tested different strategies to increase sample sizes in the course of the optimization process, each based on the reciprocal of estimated gradient norm of the objective of the column generation subproblem.

We increased sample size either in proportion to the reciprocal of the norm, or in proportion to the square of the reciprocal of the norm.

5. TEST RESULTS AND CONCLUSIONS

Fig. 3. shows the numbers of iterations with different starting sample sizes and with different increase strategies. Naturally less iterations are needed when the starting numbers are bigger.

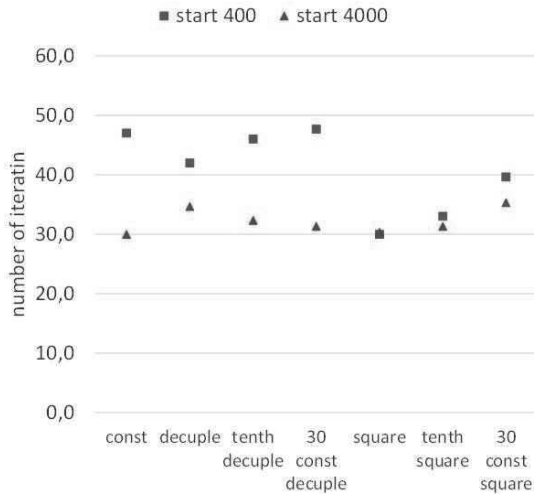

Fig. 3. Number of iteration for different samples ($\overline{\mathcal{B}} = 0.03$)

Run times don't show significant differences for different starting sample sizes, but the increase strategies based on square of the reciprocal of the norm result in longer running times (Fig. 4.)

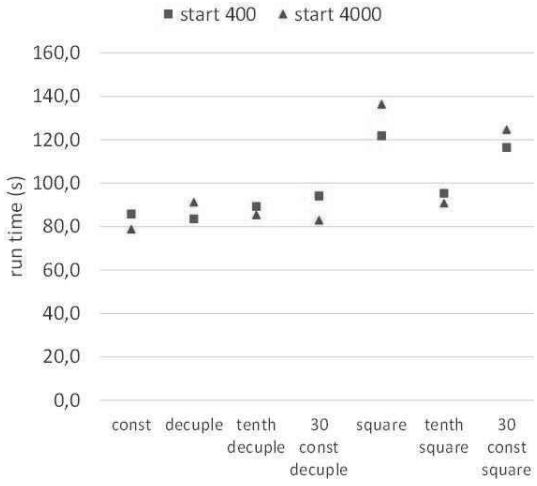

Fig. 4. Run time for different samples ($\overline{\mathcal{B}} = 0.03$)

6. ACKNOWLEDGEMENTS

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Relationship between Knowledge Management and Innovation Performance: A Literature Review

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Abstract

The purpose of this study is to review literature evidence on the nature of relationship between knowledge management and innovation performance. A critical review and semantic synthesis of literature was conducted in order to identify key dimensions and relations between aforementioned research concepts. Hence, upon results of semantic synthesis, a research framework was conceptualised. The results of literature survey reveals that studies in the field are contradictory, in some extent. While some studies claim that knowledge management produce positive impact on organisational innovation, others point to the, at best, shortcomings of knowledge management practices. Such contradictions still draws attention of academic community. By shedding some light, the results of this study might help scholars and practitioners to understand the deeper meaning of how coupling of these organisational concepts can produce competitive advantage for the organisation, as well to further clarify the fostering nature of knowledge management for the development of organisational innovation.

Keywords: knowledge management, innovation, organisational innovation, literature revie

1. INTRODUCTION

In a rapidly changing business environment, innovation becomes a prerequisite for success or even the survival of an organization. Therefore, innovation is one of the most relevant factor for the development of a company, as well as the key element for market competitiveness. It includes new ideas transformed and implemented in products, services and processes, which create a value for the company [1]. Moreover, in a turbulent economic environment, innovation is considered to be a key driver of sustainability, productivity, economic growth and business competitiveness [2].

Many researchers and practitioners have concluded that knowledge management (KM) must facilitate the creation of new knowledge, in order to gain and sustain competitive advantage. Thus, gaining knowledge positively affects organizational innovation [3].

KM involves complicated process and activities that create, identifies, shares, and adjust organisation knowledge [4]. It is an important strategy which can improve organisation competitiveness and performance, as the implementation of knowledge will lead the organisation in becoming more adaptive, innovative, intelligent, and sustainable [5].

Considering the need to understand the links between knowledge and innovation, several researchers explored the relationship between

knowledge processes and innovation outcomes [9-18].

The abovementioned interest creates the need for a review of the crucial literature that furthermore helps both practitioners and scholars to understand how the organizational concepts produce the competitive advantage for the organization. Next to this it would help making the notion of knowledge management in the field of the development of organizational skills more comprehensible.

2. METHODS AND MATERIALS USED FOR RESEARCH

Research goal was to gather insightful information about knowledge management and innovations, and provide answers for important questions: Does the knowledge managements affect the development of innovations? As well as, does the knowledge management affect the organization performance?

The data source utilized for that purpose is Scopus and Science Direct. Scopus is the largest abstract and citation database of peer-reviewed literature, which includes scientific journals, books and conference proceedings [6]. Science Direct is a website which provides subscription-based access to a large database of scientific and medical research. It hosts over 12 million pieces of content from 3,500 academic journals and 34,000 e-books [7].

Research criteria is built upon following search terms: knowledge management, innovation, organisational performance, that could occur in title, abstract or keywords. Additionally, papers were limited to articles and conference papers, published between years 2014 and 2018 and written in English language. Relevant papers were imported into Mendeley, where title and abstract review was conducted, resulting in exclusion some papers because they focused only on topic of knowledge management or innovations, not on relationship between two of them. In the next stage of review, due to limited access to databases, a number of papers that met the criteria were omitted from the final selection, which resulted in 25 obtained papers suitable for critical appraisal of studies. After reading 25 papers, 10 papers where accepted as relevant, credible, insightful and rigor enough to be included in data extraction.

For analysis of every paper is used CIMO. CIMO framework is constructed from [8]:

Context: - Clearly defined research boundaries and research space; - Identification of key aspects, factors, entities or elements;

- Identification of key characteristics of those elements.

Interventions: - Which, of the aforementioned key elements, has a mediating or moderating role?; - What is the intervention of interest?

Mechanisms: - How interventions can occur, with respect to given mechanisms?; - What are the mechanisms of interest?

Outcomes: -What are the outcomes of such mechanisms?

3. RESULTS AND ACHIEVEMENTS

After reviewing and analyzing papers by CIMO, in Table 1. are presented results for “interventions” (In step 2. METHODS AND MATERIALS USED FOR RESEARCH, it is explained in detail).

KM AND INNOVATION

In table 1. the relationship between KM, innovation and organisational performance is shown. Analysed studies are from different countries and different areas, but show the same effect. KM has a positive effect on different types of innovation, and it would be a motivation for employees and managers to use KM in their organisations. In this way they will be more innovative, and achieve competitive advantages.

Table 1. Synthesis of the literature review

Ref.	Country	Object	Proven Relationship
[9]	Iran	Automotive industry	KM has positive impact on organisational innovation (OI), organisational learning (OL) and organisational performance
[10]	Brazil	The study analyses 33 papers published in 21 journals	Technological acquisitions help biotechnology companies to access technical expertise that can support innovation. Knowledge creation and absorptive capacity mediate the relationship between knowledge acquisition and innovation. Organizational factors and KM practices are mutually reinforced thus improving innovation performance Knowledge Management (KM) successful programs help global software firms to create KM-enabled value, including innovation.
[11]	Iran	Automotive industry (Iran Khodro Company)	KM has positive effect on organisational learning (OL), organisational innovation (OI) and organisational performance OL mediates the relationship between KM on OI
[12]	Serbia	Technology and knowledge intensive industries	KM has positive impact on organisational innovation and organisational performance
[13]	Malaysia	Manufacturing sector	KM process, knowledge application and knowledge dissemination has positive effect on innovation performance
[14]	Jordan	Consultancy firms	KM Process (Acquisition, sharing, utilization) and KM Approach (codification, social network, personalization) has positive effect on innovation
[15]	Taiwan	Firms of the industrial cluster index	Knowledge creation & acquisition, knowledge dissemination & storage and KM has positive effect on innovation
[16]	Taiwan	Firms	Knowledge acquisition capability and knowledge sharing capabilities has positive effect on radical innovation
[17]	Iran	120 firms of the Iranian Power Syndicate	KM has positive effect on innovation and organisational performance
[18]	Spain	Technology firms	KM creation and KM application practice has positive effect on innovation

4. CONCLUSION

In the end, from the abovementioned literature review it was concluded that KM has a positive impact on innovations and organisational performance. The further studies should show how to use KM in right way to increase capabilities for innovation.

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Agile Project Management beyond Software Development: Challenges and Enablers

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Abstract

The main objective of this study was to examine if agile project management (APM) is applied beyond software industry and what are the main reasons for introduction of APM and also challenges encountered in its application. In 15 years since APM has been in use, it has become a cutting-edge approach practiced, primarily although not exclusively, in the software industry. There is a slowly emerging recognition that APM have something to offer within the wider project landscape and motivation for this research came from the fact that not many empirically grounded studies at the moment exist and those that are present are limited by sample size, industry or geography and it does not allow for generalizations. With the increased use of APM, it is of utmost importance to clarify if and how this concept translates outside of software domain. The study combined literature review and empirical research based on originally developed questionnaire distributed through PMI (Project Management Institute) worldwide network. Data was gathered from a survey of 334 projects, members of PMI network management professionals with 227 valid answers. Results has shown that there are a companies beyond IT and software development that has been practicing APM in different sectors.

Keywords: agile project management, APM, project management

1. INTRODUCTION

With its roots in the Agile Manifesto, which expresses the key principles and values of the movement, and after 15 years of maturation, agile project management (APM) now becoming mainstream and a cutting-edge project management approach in fast competitive markets, with fast changing technologies, innovation-driven clients, and high level of uncertainties. Up to now, APM has been adopted for software development in thousands of companies around the world and it is on the rise according to 2015 PMI's Pulse of the Profession report [1] with 38 % of responding companies reporting its frequent use, which is 8 percentage points up since 2013. Although agile-related topics are discussed, primarily, in IT and software related literature, ability to manage changing priorities, team productivity, customer satisfaction, effectiveness in resolving unexpected risks, as building blocks of APM, are for sure something that is desirable beyond software industry but still there is a lack of understanding and well defined instructions how to apply particular Agile in other domains, how to identify situations when APM might be a better solution and how to help organizations integrate agile practices into their traditional processes. Therefore, with the increased use of APM in the last decade, it is of utmost importance to clarify whether and how this concept translates outside of software domain and whether it coexists with or replaces

traditional project management and under which conditions. There is a slowly emerging recognition that APM have something to offer within the wider project landscape and motivation for this research came from the fact that not many empirically grounded studies at the moment exist and those that are present are limited by sample size, industry or geography and it does not allow for generalizations. Based on the aforementioned this study aims:

- In the first instance, to provide academics and practitioners with a coherent overview of the available theory in this new and still under-explored area.
- In the second instance, through empirical research to show which are the reasons for introduction of APM and challenges in its application in and beyond software development.

2. THEORETICAL BACKGROUND

2.1. Agile Project Management

In the last decade the research on APM and its adoption beyond software industry has emerged expeditiously due to the fact that projects are being more complex with uncertain outcomes and goals changing over time.

The concept of APM has emerged in the past decade from the software community, supported by the development of a set of practices, tools and techniques encapsulated in so-called “agile methods” or “lightweight” methods[2]. Agile methods are used to deliver customers value while dealing with inherent project unpredictability [3] relying on people and their creativity rather than on processes [4], as a counter to the traditional “waterfall” approach[2] which involves very disciplined and deliberate planning and control methods stressing the importance of requirements, but limited in a way that projects rarely follow the sequential flow, and clients usually find it difficult to completely state all requirements early in the project [5].

However, other types of projects share many of the challenges that APM solved in software development. While APM is generally applied by software development teams, the number of project managers and business experts who recommend the implementation of APM to manage projects and teams outside the software industry [6]is growing. Over time, APM migrated to other domains as well, and 48% of project managers stated that they also used agile methods for projects that are not related to software IT in the report "Agile Project Management Software User Report (2015) ". Scrum Alliances survey which covered 4452 Scrum users (Scrum is the most popular agile method), more than half of respondents said that their organization used Scrum outside of IT as well, and the highest percentage was reported in the development of new products (11%). Though agile roots are in software development organizations, changes in the business environment (e.g., growing power of customer, rapid pace of technology, and shorter business cycles) are driving organizations to look at additional ways to apply Agile. Components of agile methodology (e.g., customer collaboration, rapid production, and flexibility) allow organizations to address many of the changes in the business environment and thus it is significance to investigate agile adoption and applicability in managing projects beyond IT. Customization and flexibility depend on the level of innovation, character and degree of changes etc. and the choice of methodology remain a challenge and problem to be solved. We identified a wave of interest from researchers which proposed and investigated the application of APM in non-software projects, in variety of domains. Table 1 summarize the findings on APM applicability beyond software industry, available in literature, gain through literature review which was conducted to systematically locate, assess and aggregate the outcomes from all relevant studies in a transparent way.

Table 1. APM in different domains.

Proposed domains for APM application	Authors
APM in innovation management and product development	[7]–[10]
APM in construction and real estate	[11]–[16]
APM in education	[17]–[21]
APM in services	[22], [23]

3. METHODS

3.1. Methodology and data sample description

The aim of the empirical part of the research was to find out if APM is applied in different sectors beyond software development and what are the most common reasons to introduce APM and challenges encountered.

Data was collected from practitioners who are members of PMI or members of LinkedIn project management groups. Invitations to fill out the originally developed and validated questionnaire, via surveymonkey.com, were posted on PMI communities, LinkedIn and Facebook groups, and were also distributes through contact lists of various PMI chapters worldwide. The survey was targeted at project managers but was not restricted to people who managed projects. This study is extracted as a part from research project entitled "Extending agile project management beyond software industry" which was granted by PMI under the *Theses research grant* scheme.

The questionnaire was structured in 5 sections with 66 questions. This study is the result of the analysis of the date collected from the 5th section entitled "Your experience with agile project management". In first instance respondents were asked if their organization has experience with APM and if yes, whether APM is used only for software development or IT related projects or beyond. After that, according to the subjective assessment of respondents, reasons for introduction of APM, challenges and enablers in APM application were ranked. Descriptive statistics is use for analysis.

The initial questionnaire dissemination process was followed by a series of follow-up email reminders, if required. After a 2-month period, 334 responses were collected from which 227 was valid. Therefore, the study included 227 persons, 167 males (73.6%) and 60 female (26.4%), with 28 (12.3%) respondents aged 25 to 34, 81 (35.7%) from 35 to 44, 66 (29.1%) from 45 to 54, 40 (17.6%) from 55 to 64 and 1 respondent 75 or older, from 49 different countries worldwide. The sample encompassed staff with extended project management working experience. 148 respondents had 10 or more years of project management working experience (with 48 of them with 20-30 years and 8 with more than 30 years). The organizations were respondents were employed and to which all furthered questions are related varied in size with 43 (18.9%) organizations with 1-50 employees, 30 (13.2%) with 51-200 employees, 21 (9.3%) with 201-500 employees, 27 (11.9%) 501-1000 employees and 106 (46.7%) with over 1000 employees. In Table 2 the structure of industry sector by respondents is presented. It could be concluded from the table 2 that respondents come from various industry sectors.

4. RESULTS

In this section, study results are presented, using descriptive statistics. From the table 3 it could be seen that 135 (59.47%) of respondents declared that their organization have experience with APM out of which 85 respondents declared that their organization is using APM only in software development and IT related projects and 50 respondents declared that their organization is using APM beyond software development and IT related project.

Table 2. Industry sector

	Frequency	Percent
Advertising & Marketing	1	0.4
Airlines & Aerospace (including Defence)	5	2.2
Automotive	2	0.9
Business Support & Logistics	7	3.1
Construction, Machinery, and Homes	20	8.8
Education	12	5.3
Finance & Financial Services	26	11.5
Food & Beverages	4	1.8
Government	17	7.5
Healthcare & Pharmaceuticals	9	4
Information Technologies	57	25.1
Insurance	7	3.1
Manufacturing	11	4.8
Nonprofit	2	0.9
Real Estate	2	0.9
Telecommunications	19	8.4
Transportation & Delivery	4	1.8
Utilities, Energy, and Extraction	17	7.5

Table 3. Your experience with agile project management

		Frequency	Percent
Does your organization have experience with the agile project management?	No	92	40.53
	Yes	135	59.47
For how many years your organization has been using agile?	less than 1 year	21	9.3
	1-2 years	40	17.6
	3-5 years	35	15.4
	5+ years	39	17.2
	Missing	92	40.5
In your organization agile project management is...	...only used for software development or IT related projects.	85	37.44
	...used beyond software development and IT related projects.	50	22.03
Missing		92	40.53

In table 4 reasons for introducing APM are presented and ranked by respondents. A comparative overview is given in order to see the difference in reasons for APM introduction in and beyond software development. A list of reasons was created based on the most commonly mentioned reasons for introduction of APM in literature. Respondents had the opportunity to give multiple answers. In software development accelerate project/product delivery was ranked as most important reason, and enhancing ability to manage changing priorities, better focus on client and increasing productivity are ranked in top reasons. On the other side reducing project cost, improving team morale and improving project visibility had the

lowest rank. Beyond software development enhancing ability to manage changing priorities was ranked as most important reason, and accelerate project/product delivery, better focus on client and reducing project risk are ranked in top reasons. On the other side reducing project cost, improving team morale and enhancing delivery predictability had the lowest rank.

Table 4. Reasons to introduce APM

Reasons for introducing APM						
	In software development			Beyond software development		
	Responses		Percent	Responses		Percent
	N	Percent	of Cases	N	Percent	of Cases
Accelerate project/product delivery	61	17.30%	78.20%	31	12.90%	64.60%
Enhance ability to manage changing priorities	45	12.70%	57.70%	34	14.10%	70.80%
Increase productivity	27	7.60%	34.60%	22	9.10%	45.80%
Enhance project/product quality	22	6.20%	28.20%	19	7.90%	39.60%
Enhance delivery predictability	24	6.80%	30.80%	13	5.40%	27.10%
Enhanced client relationship	26	7.40%	33.30%	19	7.90%	39.60%
Better focus on client	36	10.20%	46.20%	24	10.00%	50.00%
Improve project visibility	21	5.90%	26.90%	14	5.80%	29.20%
Reduce project risk	32	9.10%	41.00%	18	7.50%	37.50%
Reduce project cost	14	4.00%	17.90%	12	5.00%	25.00%
Better manage teams	25	7.10%	32.10%	19	7.90%	39.60%
Improve team morale	20	5.70%	25.60%	16	6.60%	33.30%
Total	353	100.00%	452.60%	241	100.00%	502.10%

In table 5 challenges APM application are presented and ranked by respondents. A comparative overview is given in order to see the difference in challenges encountered in and beyond software development. A list of challenges was created based on the most commonly mentioned APM challenges in literature. Respondents had the opportunity to give multiple answers. In software development work prioritization and alignment among stakeholders on what to build next was ranked as most important reason, and insufficient time for testing, long feedback loops, incompatibility of agile methods with organizational processes and functions are ranked in top reasons. On the other side excessive preparation/planning, low transparency in project status, progress, and performance, lack of project management strategy, formal guidelines and standard processes and inability to handle interruptions and urgent requests had the lowest rank. Beyond software development work prioritization and alignment among stakeholders on what to build next was ranked as most important reason, and incompatibility of agile methods with organizational processes and functions, lack of predictability of business value delivered and visibility to client value at all levels (business, project, team, customer), lack of project management strategy, formal guidelines and standard processes in top reasons. On the other side insufficient time for testing, Inability to handle interruptions and urgent requests had the lowest rank.

Table 5. Challenges in APM application

Challenges introducing APM						
	In software development			Beyond sofware development		
	Responses		Percent of Cases	Responses		Percent of Cases
	N	Percent		N	Percent	
Excessive preparation/planning	15	5.60%	18.80%	7	5.30%	14.90%
Work prioritization and alignment among stakeholders on what to build next	41	15.20%	51.20%	28	21.20%	59.60%
Insufficient time for testing	32	11.90%	40.00%	6	4.50%	12.80%
Inability to handle interruptions and urgent requests	23	8.60%	28.70%	8	6.10%	17.00%
Long feedback loops	32	11.90%	40.00%	11	8.30%	23.40%
Unclear definition of roles in project team	25	9.30%	31.30%	12	9.10%	25.50%
Lack of predictability of business value delivered and visibility to client value at all levels (business, project, team, customer)	31	11.50%	38.80%	16	12.10%	34.00%
Incompatibility of agile methods with organizational processes and functions	33	12.30%	41.30%	19	14.40%	40.40%
Low transparency in project status, progress, and performance	16	5.90%	20.00%	10	7.60%	21.30%
Lack of project management strategy, formal guidelines and standard processes	21	7.80%	26.30%	15	11.40%	31.90%
Total	269	100.00%	336.30%	132	100.00%	280.90%

5. CONCLUSIONS

Agile had its start in software development and since the inception of Agile Manifesto APM, as an innovative methodology, has been practiced in software industry, mainly, but the application of agile methods has been extended to other fields. There is a wealth of literature and evidences about positive effects of APM in software industry; however, there is a lack of empirical studies in other types of industries and projects. Based on our literature review and theoretical observations we identified a wave of interest from researchers that discussed the application of APM and its principles and practices beyond software development projects, yet some of selected papers are based just on assumptions and ideas. There is a need to implement these ideas in real-world scenarios. In our study we wanted to identify if APM is applied beyond software development by respondents in our sample, consisted of project management professionals worldwide. Interesting fact is that out of 227 respondents 135 declared that their organization has been using APM with 50 (22.3%) of them declared they have been using APM beyond software development. Even though APM is not yet grounded beyond software development nor in theory or practice, this percent has shown that the application of APM beyond software industry exist and that it's not negligible.

If we formulate one general question-does agile methodology work for all organizations and all type of projects? Probably not. Just like with everything else, there is no one size fits all. There are projects with different characteristics and organizations operating in various fields. This necessarily means a diversity of solution is required and each organization should reflect on its own context and projects. But introduction of agile necessitates a culture shift for organizations, since in many ways it is contrary to traditional organization, managerial structure and how traditional project management works.

In our study the reasons to introduce APM are ranked, and in and beyond software development, most common reason are accelerating project/product delivery and enhance ability to manage changing priorities. On the other hand most important challenges encountered by respondents using APM in and beyond software development are work prioritization and alignment among stakeholders on what to build next, insufficient time for testing, long feedback loops, incompatibility of agile methods with organizational processes and functions. It could be concluded that there is not much difference in respondents' subjective perception of reasons and challenges in and beyond software development.

It could be concluded that even if it is debatable whether APM will be systematically and widely adopted, there are sufficient results, as a solid base, to believe that certain APM is utilized for projects outside software domain and it is likely that APM, will have something to offer to project practitioner in more effective execution of projects when facing with certain types of projects and project scenarios. More rigorous studies are needed to be conducted before any credible advice can be given.

For practitioners as well as for the research community this research will provide coherent overview of theory and available practices in this emerging but still ticklish field. Further research in this area will help both practitioners and researchers, to gain a better understanding of APM benefits and challenges in different domains and will encourage the introduction of agile techniques wherever proven to contribute to the successful execution the projects.

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Content Development for Virtual Reality Training

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Abstract

This paper aim to provide practical guidance for the virtual training content development using simple application that allows users to easily build their own 3D creations, animate them with code and explore them in virtual settings. A summary analysis of the extant literature is provided. Valuable contributions and fundamental methodological issues are identified and discussed. Practical implications and future research avenues are also highlighted.

Keywords: virtual reality, virtual training, instructions, CoSpaces

1. INTRODUCTION

Pioneering organizations, including GE, and Boeing, are using Virtual Reality (VR) to improve productivity, quality, and training [1]. By combining the strengths of humans and machines, VR will dramatically increase value creation for the organization [2]. VR replaces physical reality with a computer-generated environment. In turn, virtual training is a promising solution to bypass the limitations of hardware training and especially to test and secure production processes [3]. This paper aim to provide practical guidance for the virtual training content development using simple application that allows users to easily build their own 3D creations, animate them with code and explore them in virtual or Augmented Reality (AR).

The application of the VR concept requires the use of very powerful hardware and software that can provide a realistic virtual experience (e.g. VR helmets, glasses, 3D software)[4]. In contrast, AR joins real-world elements such as 3D objects, multimedia content or text data, and thus provides a higher level of interaction with the user [5]. VR systems include 3 key aspects: integration, interaction and real visualization [6]. Attachment involves surrounding users with virtual technologies and devices. VR provides new sources of efficiency for all organizations [7]. VR can significantly reduce the cost of training, services, assembly, design and other parts of the value chain [1]. It can also significantly reduce production costs by reducing the need for physical space. Key indicators for the implementation of VR in the training process are: (1) reducing training time, (2) a larger number of users who can perform an operation without previous experience, (3) reducing training costs, and (4) reducing the risk of injury.

2. METHODS AND MATERIALS USED FOR RESEARCH

The effectiveness of the VR-based training process depends directly on the quality of the prepared training material, or on the quality of the prepared virtual training environment. To properly prepare the virtual environment, it is necessary to go through the appropriate steps shown in Figure 1 in the form of an algorithm. Appropriate steps, or a defined procedure for the preparation of a virtual training environment, will be explained through an example of a virtual training environment in the process of assembly of water pumps.

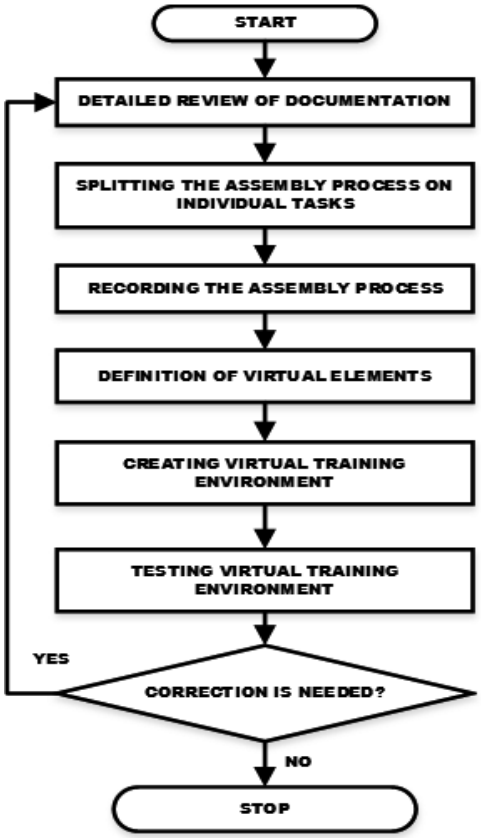

Fig. 1. Algorithm

A detailed overview of the product documentation and the process of product assembly (installation maps, design drawings, 3D models) enable the definition of all the elements necessary for defining the training process. The product assembly process is divided into simple individual tasks and based on them the training procedure is defined. The division of the assembly process into simple individual tasks depends on the complexity of the products and the assembly procedures (the smaller or higher the number of components the final product consists of, whether the assembly of products is carried out at one or more workplaces).

An example of a complex final product is a water pump consisting of many components such as enclosure, electric motor stator, electric motor rotor, bearings, sealing rings, power connector, turbine wheel, and many more. By defining tasks in the assembly of components to obtain the finished product, various tasks can be defined, such as preparatory tasks, main assembly tasks, and finishing tasks.

Preparatory tasks include all the tasks that enable the preparation of the workplace, tools and components for performing the assembly process (getting to know the workplace and preparing the workplace, familiarizing with the position of tools and components used in assembly procedures, adopting special tools, adjusting and checking the correctness of the tools, checking the correctness of the parts, etc.). The main tasks are all those tasks that serve to connect components in the assembly process (setting components in the holders, stamping the electric motor stator into the enclosure, mounting bearings on the electric motor rotor, pressing the sealing rings, and many other tasks). The finishing tasks are all the tasks that need to be done after the assembly process is complete such as returning the tool to the appropriate location, cleaning the workplace and many others.

Figure 2 depicts an example of several tasks that take place in the process of installing a water pump (a - an installing the pump housing on the carrier; b - placing the cover; c – screw the grounding screw; d - controlling the quality of component mounting). Each task in the assembly process must be well-defined in order for the training process to be carried out with a quality that directly affects the quality of finished products, production costs and others.

Recording task execution during the assembly process enables trainees to have a clear insight into the execution of preparatory tasks, main tasks and final assignments. The operator who is familiar with the component assembly procedures performs all the necessary tasks that are recorded properly. For a person who is trained to get to know the work environment better, it is necessary to record as much of the workspace as possible. During the preparation of the training for the assembly of water pumps, the operator who was familiar with the process of assembly of water pumps was at the workplace for the assembly of water pumps and performed all the tasks necessary for the assembly of water pumps.

To cover as much of the working environment as possible in one shooting cycle, 360-degree camera *Garmin Virb* was used. In order for the trainee to have as close as possible a sense of assembly process, the camera is mounted that the recorded material is as close as possible to what the operator sees with his eyes, allows trainees to have the approximately same workplace perception and tasks execution in the assembly process during training and later work

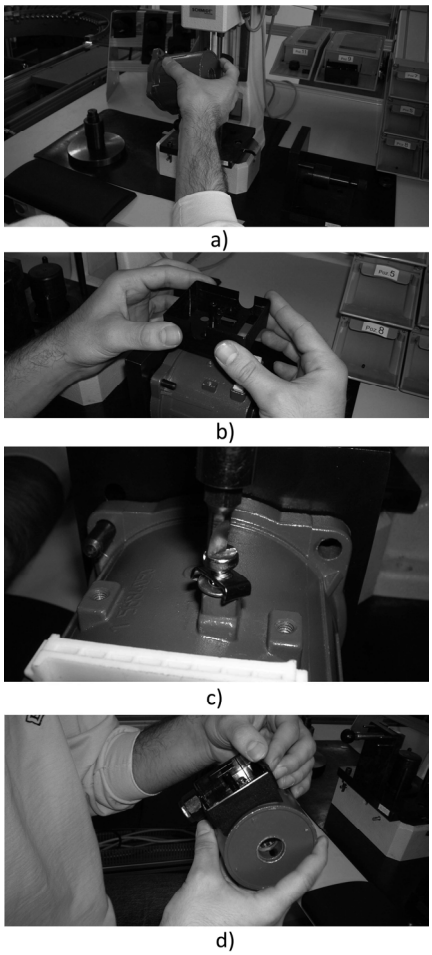

Fig. 2. Example of tasks

in the real environment (there will be no additional confusion if the perception is different, adaptation to work in the real environment is minimized).

3. RESULTS AND ACHIEVEMENTS

Defining virtual elements in the training process using VR technology depends on the complexity of the product and the assembly procedures to further explain the assembly tasks. Virtual elements can be operator comments in the form of audio and video recordings, textual information, and 2D and 3D images and animations to further clarify the specificity of some of the tasks performed during the assembly process.

Creating virtual training environments by applying VR technology is a combination of task shots performed by an operator during execution of assembly tasks and defined virtual elements that further explain the tasks that are being performed in the assembly process. There are numerous dedicated 3D softwares for the development of VR applications on the market. To create a virtual training environment in this paper CoSpaces Edu application is used [https://cospaces.io/edu]. CoSpaces Edu is a web platform, simple and easy to use, which provides all the tools needed to create a VR environment. Development of the VR environment can be realized either in the web browser on a PC or through the application for smartphones and tablets. Creating a VR environment in CoSpaces Edu is a simple process and most often consists of inserting 3D virtual objects, or from the existing library of the CoSpaces Edu platform or by importing the virtual models that the user created into a virtual environment. Virtual environments or virtual objects added to the virtual environment can be managed by programming, using Blockly programming language (visual tool for connecting logical and function blocks) or using JavaScript programming language. The virtual environment can be created in the CoSpaces Edu platform itself, ready-made solutions from the CoSpaces Edu platform library can be used, or real-environment images created using a 360-degree camera or mobile phone camera in panoramic photo mode or 360-degree mode (photosphere) can be used. As a virtual environment within this paper, recordings (created by 360-degree camera) of workplace and executed tasks in the assembly process of water pump are used. Defined virtual elements are added to this virtual environment, further explaining the tasks performed in the assembly process (text messages, audio and video, 2D and 3D animations). The Figure 3 shows a part of the virtual environment designed for training using the VR technology realized in the CoSpaces Edu application with the presentation of a virtual instructor and by marking the basic elements of the workplace.

To check the quality of the prepared virtual environment for training using the VR technology tests should be carried out on a specific control group of trainees. By testing, it is determined whether the virtual environment is properly implemented. All instructions must be clear and easily understood by the trainees. If some part of the virtual training environment is critical (poor or unclear instruction, poor angle of recorded task execution during the assembly process, etc.), the virtual environment must be corrected.

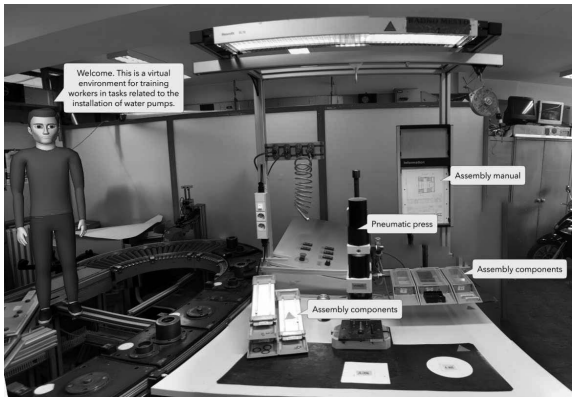

Fig. 3. Virtual environment in CoSpaces EDU

Depending on the need, the virtual environment can be corrected by re-defining individual tasks, re-capturing task execution, redefining virtual elements, re-creating virtual elements, and recreating the virtual environment. After the correction, the testing environment of the virtual training environment is repeated. If no additional correction is required, the virtual environment can be applied to the training process for a large number of trainees.

4. CONCLUSIONS

The paper presents the application of the virtual reality system using the CoSpaces Edu software platform in the process of assembly of water pumps. Virtual reality can profoundly change training and skill development, allowing people to perform sophisticated work without protracted and expensive conventional instruction. Companies can use this approach to reduce training time, training costs and risk of injury [1]. More research is needed on the empirical testing of the phenomenon. Future studies should implement VR training in the real environment and measure the performance.

5. ACKNOWLEDGEMENTS

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Evaluation of Students in Dual Higher Education

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Abstract

Dual higher education contains a combination of theoretically and practically learned knowledge. At John von Neumann University (JNU) students can choose out of many different courses where dual system is available. On these dual courses, knowledge is transmitted parallel during the practical terms when students are studying at a partner company, and during the theoretical terms at the university. JNU has a number of partner companies and institutions of different sizes and different economies, so monitoring the performance of dual students is a complex task. Measurements and evaluations related to dual higher education are of particular importance because in Hungary, this higher education method has a very short history. Developed measurement system and indicators could measure or quantify the benefits of dual higher education system, the knowledge of non-dual students differs from dual ones could be compared, and mistakes could be filtered and corrected. The purpose of this study is to review the already existing student-evaluation techniques and to select those ones by further research that are most suitable for our university to apply.

Keywords: education, dual education, practice oriented training, assessment method

1. INTRODUCTION

Dual education system is applied at several universities. It is called “Dual” in German, too [1]. In English it can be called “dual” or “cooperative” education [2]. However “co-op practice” [3], “experiential learning” [2,4], “co-op internship”, “work integrated learning” [5], “work based learning” and “university-industry partnership” mean similar systems.

In dual education theoretical and practical knowledge are synchronized. Students can study in dual form at many departments of John von Neumann University. Our university has several dual partners (companies and institutes), which are in different size from different sectors. For this reason, monitoring the performance of dual students is a complex task. The importance of accompanying measurements and assessments are particularly high, because there is no ingrained method for this in Hungary. With a well-established method the advantages of dual system can be measured and quantified, even the results with those of non-dual students can be compared, and possible to filter out the contingent faults. The purpose of this study is to review the already existing student-evaluation techniques, methods from all over the world and suggest one or more appropriate ones to apply at our university.

For a detailed overview, types and characteristics of dual study systems must be known.

2. FORMATION OF DUAL HIGHER EDUCATION

Dual higher education ancestor is the still-used “sandwich program”, which was first launched in 1903 in the UK. Essence of the program is that usually the second university year followed by a one-year traineeship, which

student can spend at one or more selected companies. The first such type of education started in engineering, but now it is also available in business, finance, psychology and sport sciences. In this form of dual education, student may decide to study for 4 or 5 years at the university. In 5-years-long type education, there is one more year of practical training. In America, the first dual-type training program was introduced at University of Cincinnati in 1906 headed by Herman Schneider from whom the idea came [2]. Schneider - who was an engineer, an architect and a teacher – recognised already during his university studies that practical subjects can not really be effectively taught in classroom environments. He noticed that many of the eminent students were working to earn money to finance their university studies. When he started working as a teacher, than tried to introduce innovations to make the lessons as practical as possible. He developed a program that allows students to study in working environment, while they earn also money. According to Schneider, the program was also designed to make it easier for students getting to be employed after their university studies by facing labour market needs and by having company relations.

Three years later, in Boston Northeastern University dean became aware of the program and was pleased to introduce it on the engineering course. The initiative was very successful, so in a few years the Cooperative School of Engineering became the largest institution at Northeastern. The number of dual courses and of dual students increased slowly. Main turning point was in 1965 when it was legislated that dual type state-run universities receive subsidy. For this reason, over two years, more than 100 universities had signed up for the dual program. By 1980, dual program was operating in nearly 1,000 American universities, and more than 200,000 students studied in this form. Dual program is spread all over the world, and is now available in more than 60 countries, not just in engineering, but also in economics, liberal arts or design courses.

Dual higher education is popular also in Canada. The first such education was launched in 1957. Canadian Association for Co-operative Education (CAFCE) has been controlling the operation of dual higher education and settling the foundations for further dual type university establishment as of 1979 onwards [5]. It also provides advices and ideas on education and evaluation methods are in use, which was greatly helpful in making this study.

In Hungary, the establishment of dual higher education was required by the simultaneous appearance of social, economic and educational needs [6]. Dual higher education model of Baden-Württemberg Dual University - founded in 1974 - was the model established also in Hungary for the requirement of larger companies (Daimler-Benz, Bosch).

In Hungary, the first dual type vehicle engineering course was launched in 2012, at Kecskemét College (John von Neumann University's Legal Predecessor) [7] where since then 8 additional courses have been added to the list of available courses. The form of dual higher education was formally added into the Hungarian higher education system in 2015.

3. SPECIALTY OF DUAL STUDY SYSTEM

Students, university and company participate in dual education. Purpose of this type of education is the dual students to have possibility to synchronize theoretical and practical knowledge and to expand their skills.

The theoretical and practical training can be parallel (in part-time), alternating (in full-time) or according to the semesters (practice at summer). In most the universities, dual system is not obligatory for all students, so dual and non-dual students study together. There are many advantages of dual study. Capabilities and skills of students are improving, such as productivity in teamwork, social and communication skills, experiential skills. They have an extensive

overview on local market and could easily get a full-time job [5, 6, 7].

Companies get motivated and cheap workforce. Students can be trained for longer time, therefore dual partners have an economic method to find new workforce. The partner company can have an influence on learning path, on specialization and training selection, consequently students study what they need for the job later at the company. Generally, companies have the possibility to choose from many students [6].

Dual education is beneficial for the university, too. Having daily contact with companies, knowledge and training fits well to the industrial requirements. Education quality may improve by developing curriculum. Dual students are more motivated also at school. Well-trained students mean a good reputation for the universities, therefore more students take up courses, thus no of teachers and disciplines are broaden. Universities get feedback on curriculum actuality, so it can be conformed to the local market requirements. They can participate in projects and get to know the recent developments.

4. IMPORTANCE AND TYPES OF EVALUATION METHODS

The world is dynamically changing nowadays and there is a lot of information students get, therefore it does not make sense to mug data but to review and evaluate how they use and systematize information. [8]. There are three types of evaluation according to its function: diagnostic, formative and summative.

Diagnostic method means monitoring the actual state of knowledge. Formative method follows personal development. While during diagnostic method the teacher gets feedback, than formative method provides student with information about himself/herself. Summative method helps to review what achieved, a typical conclusive evaluation e.g. final exam [9].

Evaluation must contain the same knowledge, competence and attitude aspects, as it is required in the curriculum. According to Bloom taxonomy- where there is six levels of cognition requirements: knowledge, understanding, application, analysis, synthesis, evaluation-, measuring only knowledge is not enough, more levels must be evaluated.

Exams must also be reformed. Instead of forcing students to mug exact knowledge, the focus is on information application skill, social and professional skills. Students must filter, apply and evaluate information that are not measurable directly by tests; consequently complex techniques must be used.

Important to make a difference between evaluating methods. Exam type must reflect to the teaching method used. More type of exams must be used, as only limited information might be gained about student performance by one method. More and more common to take an exam either face-to-face or in groups, applying unfinished sentences and questions, presentations, project works, computer simulations, essays and portfolios. By using more methods, the learning habits and developments of students considered.

Determine the exact performance of students is rather important, because this is the substantial indicator of success.

For an evaluation method, we must determine the whole process, steps, aim and the way of using data. If students feel responsible for their performance, than they know how to improve it and will try to do it so. There must be no “blind-spots” and unknown parts in the evaluation process.

5. EVALUATION OF DUAL STUDENTS

5.1. Experiences

There are few studies on the evaluation of dual students. One study mentions that half of the evaluation studies deal with student development, while the other ones investigate

the dual education system [4]. In this study, 75% of the investigations done by using a competency-based survey (test writing), while only 12.5% of the investigations were done by interviews with students or used several methods. In New Zealand, where many evaluation methods are in use, students are evaluated and interviewed, followed by a workshop where university and company representatives are present [4].

In Mosbach, Baden- Württemberg, dual students evaluated at the end of the first, second and third university years. At the first year end, students receive “done” or “failed” rating from the company. At the end of the second year, students must do a project work and a report must be made about. This documentation reviewed by company specialists and a proposal is made for the credit. After that, students have to take an exam at the board of examiners (university and company specialists), where students choose one from predetermined topics (items list) and get the final credit after the exam. At the end of the third year, the thesis defence (presentation) done [1].

Suggestions of a Canadian school for the Cs as follows [8]:

- Observation: this method provides information relatively fast, either during theoretical or practical lessons. Results can be recorded in a checklist (yes / no), in a score list (1-5), or in a short notes / comments. Important to plan criteria based on we want to monitor students and to make questionnaires / evaluation sheets ready and handy at the beginning of the survey. Worth paying attention to evaluate all students in a short time.
- Performance: curriculum includes the skills student needs to have. In order for the students to take these skills seriously and develop them consciously, they should receive feedback. It is necessary to evaluate how each student has developed / develop in this field (before going to the company and at the company).
- Journal (writing report): although it is not a formal evaluation method, journal still allows students to express their thoughts and ideas, and to develop their info-transfer skills. During self-assessment process, students can review their strengths, weaknesses, attitudes, interests and info-transfer skills.
- Interview (discussion): student interview allows the teacher to confirm student's knowledge and understanding. Discussion allows student to present how he can use information learnt and to clarify understanding regarding the subject. Brief discussion can take place between teacher and student, but it can also be extended (student, teacher, parents and / or company representative). These interviews help students to find their strong/weak verbal presentation skills.
- Paper and pencil (written examination / paper / report): this technique can be formative or summative. In many curriculum, written assignment has a decisive role, can be used to assess knowledge, understanding and concept application of students.
- Presentation: graduates must be capable of filtering, analysing and interpreting information, identifying relationships, working in team, reflecting and spreading information. Presentation technique makes it possible to evaluate these activities the best.
- Portfolio: portfolio must contain a long-term record of growth and development, which includes the required knowledge and skills. Progress monitoring is important for self-reflection and self-assessment, but it is also relevant to share with others. Portfolio making is exciting for many students, because this way progress is evident which is otherwise difficult to see.
- Personalized placement learning plan: existing skills of students assessed by this

technique and it makes a plan for those skills they need to develop during their practice at the company.

5.2. Suggestions

In order to ensure that all three participants of dual higher education are satisfied, student performance, company compliance and dual program must also be investigated and monitored [5].

In this case, our goal is to study and evaluate the activities of dual students at the company. Evaluation of company's compliance and of dual program as a whole is not part of our investigation. These areas require separate research and analysis.

Based on the above examples, we consider to combine various types of evaluation methods. Monitoring of dual student development can be easily done by techniques like presentation, portfolio and project. Important the students to know that they need this report and not being annoyed by doing it. From this point of view, presentation is beneficial, because it is expressive, instructive and easy to make. Student conferences and/or workshops are feasible to perform presentations. Projects can easily be traced by a portfolio that can even digitally be made. Students should complete a questionnaire at the end of their studies, describing their experiences of work done at the company and their development during the training. Advantage of written communication is that it provides anonymity; consequently information will not be ‘sophisticated’ or ‘varnished’. From the time/energy saving point of view, completing questionnaire online would be beneficial.

Companies should complete a questionnaire about student performance when student is about to finish his/her study. Then, student and company mentor must review it together. Next step, when questionnaire is transferred to the university where responsible teacher has a discussion about it with student. Questionnaire content should accommodate with student responsibility.

5.3. Comparing dual and non-dual students

Possible that students complete a test before they start university and after graduation to get feedback on their development [2]. Both dual and non-dual students can be compared by this method. Common IQ tests are not really appropriate for this purpose. Competence-based professional test may be appropriate for students studying on technical courses. Three specifications of this test are available at John von Neumann University: mechanical interpretation, diagram analysis (thinking logical) and numerical analysis (economic approach). In addition, the harder Raven test can also be used, which measures general competence. Harder means that this test type is recommended for university students/graduates. Suggested to inform dual partners about specific competency tests, with the help of their collaboration tests are easier to be completed and approved by students. These tests are used by many leading companies all around the world, for example, as part of a job interview. Quality of tests is proven, due to confidential content, it can only be used on paper.

Dual and non-dual students can also be compared by completing a questionnaire. Short sentences/questions help to keep student motivation (utmost student to complete) and to optimize evaluation time.

6. CONCLUSIONS

John von Neumann University has a number of partner companies and institutions of different sizes and different economies, so monitoring the performance of dual students is a complex task. Measurements and evaluations related to dual higher education are of particular importance because in Hungary, this higher education method has a very short history.

The aim of this study was to take looking at the already existing evaluating methods and propose some methods, which can be appropriate for JNU.

Recommended to use more type of evaluation methods (at least one written and one oral type). Students monitoring by presentation, portfolio or project work presentation. Realization of presentations could be on events such as workshops and conferences. For dual and non-dual students, it would be expedients to complete a questionnaire about their self-development. Possible to complete test before the first and the last semesters, so students and their development could be compared. By last two methods also dual and non-dual students can be evaluated, so differences between the two learning types could be quantified. Before compiling an evaluating system, we must take into consideration test time, evaluation time and information quality.

7. ACKNOWLEDGEMENTS

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Use of Digital Media with an Aim of Improving the Teaching Process

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Abstract

Significant potentials of digital media in the field of teaching and learning are reexamined. Various opinions and strategies are analysed with an aim to create a set of simple, comprehensive and efficient recommendations to future teachers. These recommendations will be subjected to further discussion in order to introduce future standards with a primary aim to increase the quality, efficiency and overall outcome of the teaching process.

Keywords: digital media, teaching process, improvement of the teaching process

1. INTRODUCTION

Digital media and networks have become an inseparable part of our lives and therefore of the teaching process as well. When addressing a complex issue of education for information society and society of knowledge, considering a methodological approach to education is unavoidable. Digital media are to contribute to maintenance, enhancement and proliferation of knowledge. Digital media encourage drawing up and use of various multimedia contents, interaction between the content and the user and among a group of users, as well as development of team work and creativity of students.

The purpose of education is to equip a young person with knowledge and skills and to prepare him/her for to assume an active role in a modern society in which he/she lives. Using new media in schools has to be in essence part of education policy of a society.

Considering possibilities of selection of a methodological framework in digital-media-supported teaching process is based on two key elements: one is a pragmatic approach that implies understanding practical objectives, while the other is related to the certainty of a need to link the choice of methodology with a theoretic approach taken by educator. A significant progress in this case depends on the essence and the method to almost the same extent. Thus, none of them may be underestimated as that would diminish the importance of the other one as well. Talking about analysis, the question is how to modify the basic procedures when applying the content analysis: operationalisation of theoretical assumptions, sample selection, analysis unit, classification criteria, coding and decoding procedures of messages sent. Besides, the issue relating to the content analysis is that of comparability of results and observance of the principle of generalization in the analysis.

2. THE DIGITAL AGE AND LEARNING

Dominant educational prospects in the pre-digital age were reflected in the industrial model of production. Such prospects have prevailed even in some modern-time classrooms. Accordingly, learning has been accomplished under controlled conditions, with information divided on specific topics. Students demonstrate what they have learned from books or teachers.

In a digital age, duplication of identical or similar resources relating to the same concepts for different courses turns out to be insufficient and often impossible to accomplish (Thornburg, 1998).

Digital age teaching methodology is an educational logic of selection of a certain method of work whereby it is primarily necessary to have an insight into teaching material that is shared, as well as into possibilities of its adoption and the learning method most adequate for the given field, necessary supplementary activities and similar. The method must be in compliance with the vision and purpose of the course, its values, as well as general and specific objectives of educational process. It must correspond to the objectives of education and should answer the following two questions:

- Is the selected method in accordance with the values being the content of education?
- Is the selected method appropriate for the specific objectives set for the given learning programme?

In addition to that, learning outcomes must to be measurable and continuously checkable as they relate to the principal learning factor and need to take regard of a change in educational process that so far has been in the domain of teaching and now it is to be directed to development of competences.

3. PROBLEMS WITH KNOWLEDGE-SHARING IN A DIGITAL AGE

Jacobsen (2001) believes that a vast number of teachers worldwide are not capable of adopting teaching and task learning technologies whereby the gap between the presence of technology in schools and its efficient application is too big. A poor and infrequent use of technology in teaching process is a consequence of a lack of vision of technology potential in the improvement of learning and teaching processes. Teachers believe that introduction of technology into teaching process is time consuming, yielding more difficulties than benefits (Sheingold and Hadley 1990). Insufficient use of technology in the teaching process is probably a consequence of a lack of vision of possible improvements the technology might bring to teaching and learning. The efficiency of integrating technology into education depends primarily on its capability to engage students in the process of learning (Dexter et al., 1999).

Present-day graduates are facing technological competences that emphasize a capacity for innovations, leadership, collective identification of problems and multi-disciplinary cooperation in a digital environment. Digital media empower students to manage their time (Sharples, 2000), enabling them to study when it suits them best.

A worked out integration of technology is accomplished when students possess tools necessary for timely obtaining of information, their consolidation and analysis (Harris, 2005). Numerous researches show that to have a devised integration of technology into a teaching process learning is of crucial importance, designed so to encourage students to learn in a social context, assisting them to acquire new knowledge, solve new problems, inciting creativity and critical thinking (Griest 1996; Hoffman 1997; Mergendollar 1997; Richards 1998).

Lim and Tay (2003) classify ICT tools used to improve the teaching process, distinguishing among information, situational, communication and constructive tools. .

Information tools are applications that store and provide enormous quantities of information in different formats (e.g. databases, ecyclopedias, the Internet). Situational tools are systems that place students into an environment in which they can experience the context (e.g. simulations and games). Communication tools are systems facilitating communication between students and other parties (e-mail), whereas constructive tools can be used in information

manipulation, knowledge building or for production of certain material goods (Lim and Tay, 2003).

4. CONCLUSIONS

Digital technologies offer an opportunity of accomplishing more precise goals in the teaching process. If goal formulation is viewed as an oprerationalization of different outcomes of learning we want to accomplish in the course of educational process, it is essential how those aims are translated into a specific outcome. How to bring together aims relating to the welfare of all parties involved in the educational process and, on the other hand, of a broader social community? Under modern-time circumstances in which knowledge multiplies rapidly implementation of motivation for lifelong learning and development is crucial. The educator's (holder's) position is thus the following; not only must he/she know more about the issue that is addressed and shared by new technologies, but he/she is also to adapt, translate and contribute to consolidation of individual outcomes of learning and practice requirements in an intelligible and acceptable way.

Education is a vibrant, dynamic and future-oriented activity and it should be carefully contemplated which is the language of new generations which they understand and to change or, more precisely, adapt the methodology of teaching process planning and plan learning so that it corresponds to their process of thinking.

A vast number of researches point to the importance of use of technology in the teaching process; introduction of new technologies poses a challenge, and the biggest challenge for teachers and educators is their evaluation. However, a mere taking over of work methodology in education has proved insufficiently useful when certain problems are concerned, as it is not possible to use them without prior preparations and modifications as to culturological frameworks.

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AGRICULTURE

The New Insect Pest Released by the Climate Change in Hungarian Agriculture

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Abstract

The variability of the climate has a fundamental effect on the composition of the insect species in the regional fauna and on the seasonal cenological changes in some local habitats (microhabitats, biotopes). The direct impact of weather is influenced by the phenological and population dynamics processes, which indirectly results in the transformation of area and biodiversity. In the case of a number of insect species, their distribution area has been observed to be more northward and to higher altitude. In Hungary, the following insect species appeared in climate change: South American tomato moth (*Tuta absoluta*), Spotted wing drosophila (*Drosophila suzukii*), Southern green stink bug (*Nezara viridula*).

Keywords: climate change, Hungarian agriculture, South American tomato moth (*Tuta absoluta*), spotted wing drosophila (*Drosophila suzukii*), southern green stink bug (*Nezara viridula*)

1. INTRODUCTION

The biggest challenge for the 21th century is climate change. Today, it is not arguable that the planet's surface temperature and climate are changing. This fact is supported by research findings and observations [1]. Warming is largely anthropogenic, and it is attributable to the enrichment of atmospheric greenhouse gases. Carbon dioxide is the second most important greenhouse gas in the atmosphere after water vapour. The amount of carbon dioxide found in the atmosphere has changed dramatically throughout the earth's history. Before the industrial revolution, the Holocene had a carbon dioxide concentration below 280 ppm [2], while from 1800 it has grown steadily to 380 ppm [3],[4],[5]. International Panel on Climate Change (IPCC) estimates atmospheric carbon dioxide concentrations for 2100 between 540 and 970 ppm [1].

Combustion of fossil fuels and carbon dioxide emissions during deforestation is more than the biosphere and the oceans can absorb during this time. As a result, the carbon content of the atmosphere is constantly increasing. Due to climate change, environmental biotic and abiotic factors are changing, the consequences of which only appear in the long run. Due to the levelling effect of Earth's oceans due to the high thermal capacity and the slowness of other mediation processes, the Earth's climate is slowly following its modifying effect. Therefore, even if the concentration of greenhouse gases does not rise further [6].

The Hungarian contexts and changes in global climate change can be traced in different sectors. The spatial effects of the Hungarian climate and the local phenomena of the weather make it clear that Hungary needs to deal with the peculiarities and the causes, the prevention and the possibilities of remedying it. In

Hungary, serious damage is caused to inland waters, floods, droughts, flood-like rain, hail, heat waves, rising UV rays, early and late frosts, snow storms, wind storms, forest and fires, new pathogens and pests. The impact of climate change in Hungary is felt in all sectors.

The areas most affected by climate change [7]: 1. Water management: flood, inland water, drought, water management; 2. economy, society, infrastructure; 3. human and animal health, food safety, water supply; 4. Human-impacted ecosystems; 5. natural ecosystems.

Human-impacted ecosystems - forestry, crop production, animal husbandry, and gardening - must also adapt to the consequences of climate change. The mass influx of insect pests occurred mainly in Transdanubia. Due to warming, drier and warmer conditions are expected to be spread more easily among the more adaptable species (ragweed, woolly goat, sole) [7].

Among the causes of climate change published in Hungary, I will describe four insect pests: South American tomato moth (*Tuta absoluta*); Spotted wing drosophila (*Drosophila suzukii*); Southern green stink bug (*Nezara viridula*).

2. METHODS AND MATERIALS USED FOR RESEARCH

1, **South American tomato moth**.

Tuta absoluta biology: The tomato leafminer *T. absoluta* (Meyrick) (Lepidoptera: *Gelechiidae*) is one of the most devastating pests of tomato in South America [8],[9]. This pest was initially reported in eastern Spain in late 2006 [10], and has subsequently spread throughout the Mediterranean Basin and Europe [11]. *T. absoluta* (figure 1) was first reported from Hungary in 2010. It first appeared in greenhouse grown tomato in Kiskunfélegyháza [12]. The larva feeds voraciously upon tomato plants, producing large galleries in leaves, burrowing in stalks, and consuming apical buds and green and ripe fruits. It is capable of causing a yield loss of 100% [13]. Tomato is the main host plant, but *T. absoluta* also attacks other crop plants of the nightshade family, including potato, eggplant, pepino, pepper and tobacco [14]. It is known from many *solanaceae* us weeds, including *Datura stramonium*, *Lycium chilense* and *Solanum nigrum*. The adult moth has a wingspan around one centimetre. In favorable weather conditions eight to ten generations can occur in a single year.

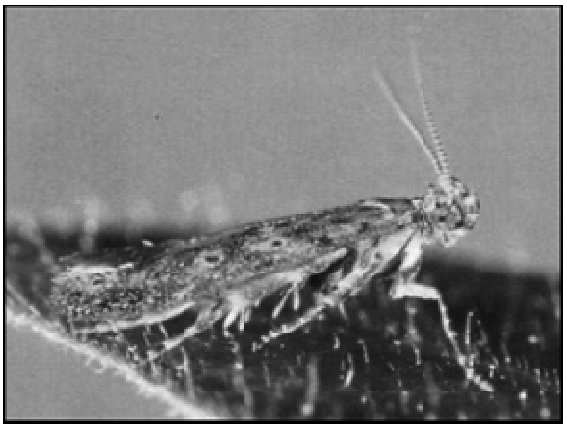

Fig. 1. Tuta absoluta

The female puts a total of 250-300 eggs on the leaves or on the stem. It does not differentiate, it places eggs on both the colour and the back of the leaf. The caterpillars are released under favourable temperature conditions for 4-5 days. After a series of shedding, the caterpillar gets caught in a leaf, soil, or other hiding place. Often uses the various plant tools, which can easily extend from one place to another. The puppy stage is 9-10 days long. The females adults have a lifetime of 10-15 days, the males are only 6-7. Females mate only once a day, totalling 6 times in their lives. Unrestricted generations of species are constantly present under appropriate temperature conditions, up to 10 to 12 generations of growing plants can grow each year, which overlap each other. Progression is independent of a long day reality. The females lay fertile eggs without mating, so it is able to reproduce the species parthenogenesis.

Protection: 1, Biological: Against pests are well deployed in *Macrolophus melanotoma* predatory bedbugs and *Trichogramma achaeae*, of the stock of *Baciullus thuringiensis* var.

kurstaki [15] bacterial species used. 2, Chemical: A chemical defense system of insuring complementary role to get the bursts of spinosad, imidacloprid pesticide can be used.

2, **Spotted wing drosophila** (*Drosophila suzukii*).

Drosophila suzukii biology: Spotted Wing Drosophila (SWD) is a new fruit pest recently discovered in Davis County, Utah (August, 2010). Because this pest is widespread in the western and south-eastern United States, it is considered "non-actionable," meaning no import or export restrictions or quarantines will be implemented. SWD is similar to other vinegar flies (genus *Drosophila*), except they can infest unripe fruit. *D. suzukii* can infest un-ripened (pre-harvest), ripe, over-ripe, and spoiled fruits. SWD attacks a broad range of fruits, including tree fruits, berry fruits, and vegetable fruits [16]. *Drosophila suzukii* (figure 2) was first reported from Hungary in 2012 [17].

The lifespan of *D. suzukii* varies greatly between generations; from a few weeks to ten months [18]. Generations hatched early in the year have shorter lifespans than generations hatched after September [18]. Research shows that many of the males and most of the females of the late-hatching generations overwinter in captivity - some living as long as 300 days. Only adults overwinter successfully in the research conducted thus far. In Washington state, *Drosophila suzukii* has been observed in association with two exotic and well-established species of blackberry, *Rubus armeniacus* (= *Rubus discolor*) and *Rubus laciniatus* (the Himalayan and Evergreen Blackberries, respectively.) [19]. The fly has been observed reproducing on many other species of soft-skinned wild fruit, however, research is still ongoing to determine the quality of individual species as reproductive hosts. Adults emerge from overwintering when temperatures reach approximately 10 °C (268 degree days) [19]. The fertilized female searches for ripe fruit, lands on the fruit, inserts its serrated ovipositor to pierce the skin and deposits a clutch of 1 to 3 eggs per insertion. Females will oviposit on many fruits and in regions of scarce fruit; many females will oviposit on the same fruit. In captivity in Japan, research shows up to 13 generations of *D. suzukii* may hatch per season. A female may lay as many as 300 eggs during its lifespan. With as many as 13 generations per season, and the ability for the female to lay up to 300 eggs each, the potential population size of SWD is huge. It is also important to note that males of Spotted wing drosophila become sterile at 30 °C and population size may be limited in regions that reach that temperature.

Fig. 2. Drosophila suzukii

The larvae grow inside the fruit. The oviposition site is visible in many fruit by a small pore scar in the skin of the fruit often called a "sting". After 1 or 2 days, the area around the "sting" softens and depresses creating an increasingly visible blemish [19]. The depressions may also exude fluid which may attract infection by secondary bacterial and fungal pathogens [20]. Larvae may leave the fruit, or remain inside it, to pupate.

3, **Southern green stink bug** (*Nezara viridula*)

Nezara viridula biology: The adult males can reach a body length (from front to elytral apex) of about 12.1 millimetres, while females are bigger, reaching a size of about 13.1 millimetres. The body is bright green (figure 3) and shield-shaped and the eyes are usually reddish, but they may also be black. They differ from the similar green stink bug (*Acrosternum hilare*) by the shape of their scent gland openings, which are short and wide in *N. viridula*, and narrow and long in the green stink bug [21].

The female lays 30 to 130 eggs at a time, in the form of an egg mass glued firmly to the bottom of a leaf. The eggs are barrel-shaped, with an opening on the top [21]. The eggs take between 5 and 21 days to develop, depending on the temperature [22]. The new-born larvae gather near the empty eggs and do not feed until three days later, after the first moult. They moult five times before reaching maturity, increasing in size each time. Each instar stage lasts about a week, except for the last one before the metamorphosis, which is a day longer [21]. Up to four generations can develop in one year, with eggs developing into adults in as few as 35 days in mid-summer. Up until their third moult the larvae aggregate together on the host plant, the purpose of this aggregation is probably pooling of chemical defences against predators, for example ants [22].

Fig. 3. Nezara viridula

Nezara viridula is a cosmopolitan species, living in tropical and subtropical regions of Americas, Africa, Asia, Australasia and Europe between 45 degrees north and 45 degrees south [22]. Its exact origin is unknown, but it is believed to have originated from the Ethiopia region of East Africa, from where it has spread around the world thanks to its strong flight and human trade routes [22]. *N. viridula* was first reported from Hungary in 2002. Southern green stink bug reproduces throughout the year in tropics. In temperate zones this species presents a reproductive winter diapause, associated with a reversible change of body colouration from green to brown or russet [23].

3. CONCLUSIONS

The Hungarian contexts and changes in global climate change can be traced in different sectors. Due to warming, drier and warmer conditions are expected to be spread more easily among the more adaptable species (common ragweed, woolly goat, sole). As a result of climate change many new pests have appeared in Hungary. New pest control is a new challenge for farmers.

4. ACKNOWLEDGEMENTS

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Effect of Nitrogen Fertilizer Treatment on the Production of Hydroponic Lettuce

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Abstract

Lettuce (*Lactuca sativa convar. capitata* L.) is a significant vegetable, rich in vitamins, and has several beneficial characteristics in the course of growing without soil: faster development, higher average of yield, balanced and schemed development, and furthermore, growing can be automated, environmentally friendly, and growing does not require significant manual labour. The aim of this research was to determine the optimal nutrient concentrations of nitrogen to quantify the proper fertilizer concentrations for hydroponic lettuce (*Lactuca sativa convar. capitata* L.) cultivation in the aspect of biomass production.

Keywords: lettuce, nitrogen fertilizer, hydroponic, yield, greenhouse

1. INTRODUCTION

Lettuce became from a seasonal vegetable into an all-year grown food having a wide range of species. Modern technologies, by using hydroponic lettuce growing, permit continuous cultivation of lettuce for 12 months every year [1]. The average consumption of the plant increased during the previous decade, so it can be inserted into modern healthy nourishment. Lettuce (*Lactuca sativa convar. capitata* L.) is a significant vegetable, rich in vitamins and minerals as well. Growing in hydroculture has several beneficial advantages compared to the soil growing as regard of: faster development, higher average of yield, balanced and schemed development. Furthermore, growing can be automated by electric technologies, in an environmentally friendly way, and the production does not require significant manual labour [2], [3]. By the use of an automated (electronic technology) system, the nutrient solution can circulate several times a day in the hydroculture channel system [4]-[13].

The aim of this research was to determine the optimal nutrient concentration of nitrogen to quantify the proper fertilizer concentration for hydroponic lettuce (*Lactuca sativa convar. capitata* L.) cultivation in the aspect of biomass production. In the course of the experiment, the nutrient element concentrations nitrogen was determined in the leaves of lettuce.

2. METHODS AND MATERIALS USED FOR RESEARCH

The hydroculture experiment was set up in two periods: In spring of 2017 and 2018 (nitrogen treatment). The experiment was conducted in the greenhouse of the Faculty of Horticulture and Rural Development at the John von Neumann University, Kecskemét, Hungary.

During the course of the experiment in 2017 and 2018 springs, the nitrogen supplements were

added in the form of NO_3. The following doses of nitrogen were added to the standard nutriment solution in our experiment: 100-, 200-, 300-mg/L solution. The treatments were carried out with 3 repetitions in randomized block design. In the control treatment plants were grown with the use of standard nutriment solution without nitrogen supplement. The necessary nutrient solution was made from the following water-soluble fertilizers: 80 g Ferticare complex (N 14%, P_2O_5 11%, K_2O 25%); 359 g $Ca(NO_3)_2$ (N 15%, Ca 19%, CaO 26%); 20 mL 60 m/V% HNO_3 added to 120 litres of water. Experimental plants were propagated by seeding and subsequent transplant raising in glasshouse. Seedlings were transplanted to multi-cellular transplant raising trays on 6th of March 2017. The lettuce seedlings were placed into rock cotton cubes, and put into hydroponic growing channels on 17th of March. The first harvest took place on 11th of May 2017, when the biomass was recorded. In second year (2018) a seedlings were on 1st of March 2018. The lettuce seedlings were placed into rock cotton cubes, and put into hydroponic growing channels on 21th of March. The first harvest took place on 14th of May 2018.

Electrical conductivity in nutrient solutions was measured by laboratory EC-meter (type ORION 3Star) in both year, in two repetitions (in two growing channels), respectively [14].

3. RESULTS AND ACHIEVEMENTS

We took samples from the hydroponic tanks to test their EC. Changes in the electric conductivity are shown in Table 1. The control had the lowest EC values in 2017 (1.34 mS/cm) and in 2018 (1.35 mS/cm). The 300 mg/L N treatment had the highest EC values in both years (4.11 and 4.65 mS/cm). The EC values increased along with the nitrogen concentration.

Table 1. EC values of nutrient solutions (2017-2018)

Treatments	Years	
	2017	2018
Control	1.34	1.35
100 mg/L N	2.15	2.27
200 mg/L N	3.09	3.38
300 mg/L N	4.11	4.65

We took samples from the hydroponic tanks to test their pH (Table 2.). The control had the highest pH values in both years (7.71 and 7.63). The 300 mg/L N treatment had the lowest pH values in 2017 (6.83) and in 2018 (6.87). The pH values decreased along with the nitrogen concentration.

Table 2. pH values of nutrient solutions (2017-2018)

Treatments	Years	
	2017	2018
Control	7.71	7.63
100 mg/L N	7.13	7.25
200 mg/L N	7.00	7.06
300 mg/L N	6.83	6.87

The lettuce grew at a proper rate in the stone wool. The development of the lettuce head weight is shown in Figure 1. in 2017 spring, and in Figure 2. in 2018 spring. The highest lettuce head weight mean was measured in the 300 mg/L N treatment (197 g) in 2017 spring. The lowest head weight mean was measured in the control group (149.8 g) in 2017.

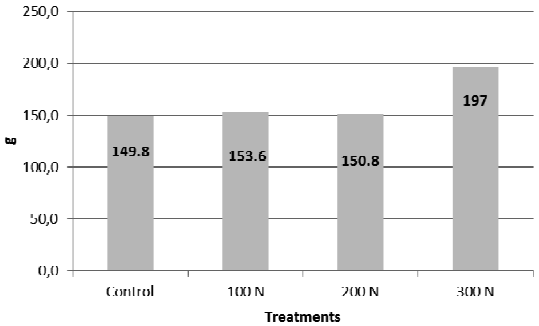

Fig. 1. Lettuce head weight (g) in 2017 spring

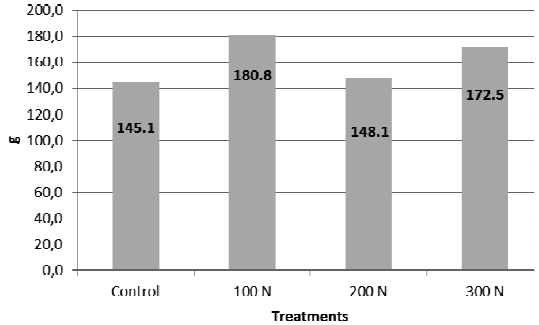

Fig. 2. Lettuce head weight (g) in 2018 spring

The 100 mg/L nitrogen treatment (180.8 g) and the 300 mg/L N treatment (172.5 g) lettuce head weight values are similar in 2018. The lowest head weight mean was measured in the control (145.1 g) in 2018 spring.

The highest nitrogen concentration were determined in the leaves (Figure 3.) was the 300 mg/L treatments (3.84 m/m%) in 2017. The lowest was the control (2.8 m/m%). The 100 mg/L and the 200 mg/L nitrogen values were similar in 2017.

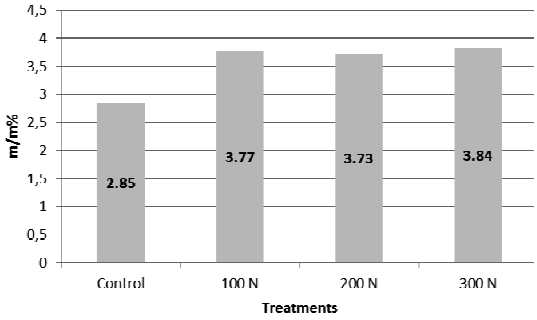

Fig. 3. Nitrogen content of dry matter in the lettuce leaves (m/m%) in 2017 spring

The highest nitrogen concentration were determined in the leaves (Figure 4.) was the 300 mg/L treatments (3.94 m/m%) in 2017. The lowest was the control (2.68 m/m%). The 100 mg/L and the 200 mg/L nitrogen values (3.74 and 3.67 m/m%) were similar in 2017.

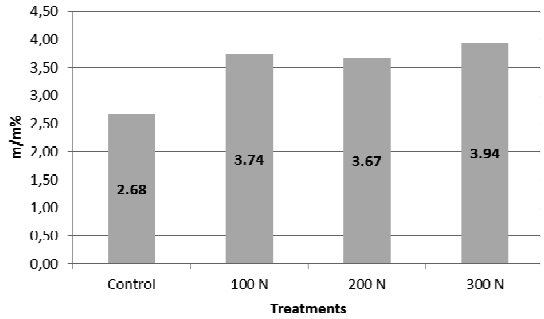

Fig. 4. Nitrogen content of dry matter in the lettuce leaves (m/m%) in 2018 spring

4. CONCLUSIONS

Despite the widely and commonly used traditional agricultural production technologies, hydroponic growing also has a great role in nowadays and in the future as well. In the course of our experiment we found that the easily purchased materials (stone wool, medium raw material) can be used cost-effectively in the hydroponic cultivation.

Human labor is only needed for planting into stone wool, filling in the nutrient solution and harvesting. More work is needed for production on a field. In the case of hydroponic growing there is no need for weeding, fertilizing or groundwork. The leaves turning brown and rotting can be avoided with using adequate nutrient solutions. Higher salt concentration or excessive nutrient ratios may easily cause inadequate growing or disorders.

The highest lettuce head weight mean were measured in the 300 mg/L N treatment (197 g) in 2017 and the 100 mg/L nitrogen treatment (180.8 gram) in 2018.

The lowest lettuce head weight mean were measured in the control group values in both years (149.8 g and 145.1 gram).

The highest nitrogen concentration were determined in the leaves (figure 3. and figure 4.) was the 300 mg/L nitrogen treatments values in both years (3.84 m/m% and 3.94 m/m%).

The lowest lettuce leaves nitrogen concentration were measured was the control values in both years (2.85 m/m% and 2.68 m/m%).

5. ACKNOWLEDGEMENTS

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IoT Application in Agro-Industry

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Abstract

This paper aims to present IoT technology and its implementation in agro-industry. IoT technology can of great help when implementing in tracking state of food during not only supply chain but also in production phase. In fruit production different types of protective nets can be implemented. In this paper a concept of implementation of exclusion nets as a protection of pests with integrated IoT technology with the purpose of monitoring micro-climate conditions is presented.

Keywords: IoT, food production, sensors, exclusion net

1. INTRODUCTION

Internet of Things (IoT) system is complex technology domain and it consists of distributed devices as well as distributed services. This complex system, and its components are collaborating with each other in order to fulfil common goals of IoT applications. IoT application can be in different fields: environmental monitoring [1], healthcare [2] and its sub application medical [3], and pharmaceutical [4], telematics [5], personal and social [6], home automation [7], media and entertainment [8], logistics [9], industrial automation [8], energy management [10], traffic management [11], payment [12], insurance [8].

There are also some of applications that are related to agro-industry field [13], [14], [15]. IoT can be used at different levels in the agro-industrial production chain [16], [17]. This means that IoT can be implemented in following agro food phases: production, distribution, processing and sale of food products.

Monitoring of different important factors, which are specific for each phase of food product life cycle, influence the quality of sold food product. Since the price of final food product depends on quality of food it is very important to balance the resources engaged in each phase of food product life cycle.

The first and most important phase in food product life cycle is food production. If food quality at this stage is at a lower level, the final food quality will be also at lower level thus causing lower sale price. IoT technology can be implemented in this phase in order to maximize the food product quality. In this paper a concept of implementation of IoT technology in orchards is presented, with the purpose of monitoring micro-climate conditions.

2. IOT IMPLEMENTATION IN ORCHARDS WITH NETTING

IoT is built on three pillars, related to the ability of smart objects to [18]:

- be identifiable - object must have unique identification),
- to communicate - object must have hardware and software capabilities to connect to network and communicate with other objects)
- to interact - either among them-selves, building networks of interconnected objects, or with end-users or other entities in the network.

Basic technology needed for IoT implementation in orchards is wireless sensor networks (WSN). WSN consist of spatially distributed autonomous sensor-equipped devices to monitor physical or environmental conditions. If implemented in orchards, basic micro-climate information that can be collected with WSN are: air temperature, air humidity, soil temperature and soil humidity. WSN is very convenient technology since it allow different network topologies and multihop communication (in most cases Bluetooth communication is used). Recent technological advances in low-power integrated circuits and wireless communications have made available efficient, low-cost, low-power miniature devices for use in WSN applications which is of most importance since, in most cases orchards are in distant location, which is far away from any durable/stable power supply.

In orchards, there are several types of protecting nets that can be implemented. For cherry and stone fruit coverage, there are drapeover nets for bird protection. For apple orchards there are, in most cases, net protection from birds, sun and hail damage. Dimension of nets depend on the size of the trees, row spacing, and the terrain upon which the orchard is being grown. Micro-climate conditions depend not only on type of net but also on its colour, e.g. mean daily temperatures varied more than 0.5 to 1 degree [19].

In recent years another type of net protection occurred for controlling vertebrate pests and some insect pests- exclusion net. This type of netting is reliable because it places a full physical barrier between the pest and the crop, which is different from other kind of netting that covers only treetop. In case of vertebrate pests there are other solutions (cheaper ones) which can be implemented like sound and light systems to deter animals from feeding in an orchard, but these systems can be ineffective in some situations (e.g. when animals are starving).

There are two types of exclusion netting systems that can be used by growers [20]:

- Full canopy netting—The net is held permanently by a rigid structure of poles and tensioned cables over the entire orchard (Fig 1.).
- Tunnel netting—A series of light frames connected by wires are erected at intervals along the row to support the net and hold it away from the tree (Figure 2). The nets are placed over the frame only when the fruit approaches maturity and are taken down after harvest.

There are some research that analyse micro-climate conditions under hail netting which is, in most cases used in Serbia (Figure 3.). In research on hail-netted apple orchards in Queensland, New South Wales and Victoria [21] studied the changes to the under-net microclimate. It was found that:

- Light levels, assessed by measuring photosynthetically active radiation, were reduced by 20–27% under black net, 18% under grey net and by 12–15% under white net.
- Humidity was consistently increased by up to 10%. After rainfall the humidity under the net remains high and takes longer to fall than under non-netted trees.

Fig. 1. Full canopy netting

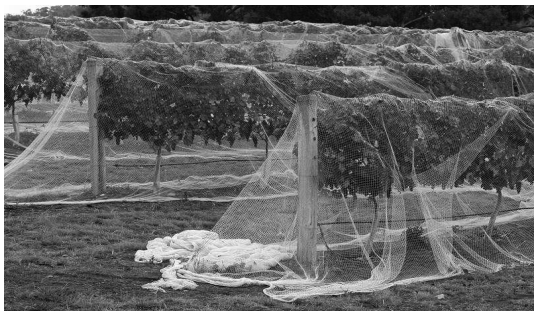

Fig. 2. Tunnel netting

Fig. 3. Hail netting

- Hail net had a minimal effect on air, grass or soil temperature. On warm to hot days air temperatures under the net, measured in a Stevenson screen, were reduced by 1 °C to 3 °C when compared to recordings in a Stevenson screen outside the net. The Stevenson screen excludes radiation and restricts wind, permitting a 'true' measure of air temperature. The temperature under black hail net may 'feel' cooler because light levels are reduced. The temperature under white net may 'feel' higher on hot days because of reflected light off the net.
- Wind speed is reduced by up to 50% within the netting.
- Hail net has little effect on night time temperatures and does not offer frost protection.

All this leads to a conclusion that hail netting has influence on micro-climate conditions.

3. IOT SOLUTION

There are no researches on how exclusion net influence micro-climate conditions, and since it is full netting in case of exclusion net and not only treetop, as in hail net, the assumption is that in case of exclusion nets micro-climate conditions will be significantly changed.

For the purpose of monitoring the micro-climate conditions of orchards under exclusion nets, proposed solution with central unit made up of a Raspberry Pi computer with peripheral devices, microcontroller sensor board with sensors and a web service for accessing the web database is used. The reason for choosing this set-of is because it is economical and most effective for further research. The chosen microcontroller sensor board can collect data with a minimum of six sensors. At the moment, there are four sensors connected to this board: air temperature, air humidity, soil temperature and soil humidity sensors. It is planned that, beside these sensors, also light sensor and wind speed sensor be connected.

After measurement, the values from the sensors (air temperature, air humidity, soil temperature and soil humidity) are transferred via Bluetooth communication from microcontroller sensor board to a Raspberry Pi computer. The data collection system then sends the measured data to the appropriate web service, if the internet connection is available. If for some reason the Internet connection is not available, the measured parameters are stored locally in the database at Raspberry Pi itself. When the internet connection becomes available, unsent data is resent, and synchronized with database in cloud. Synchronization is done in only one direction, from sensors to the cloud. In the event that an internet connection is not available throughout the entire measurement period, the data can be downloaded in .csv format, using a portable memory (USB flash or SD card memory) and then processed, analysed or manually sent to the web service.

The central unit is a Raspberry Pi 3 model B with computer (Figure 4). The computer core is Broadcom BCM2837 SoC (System on Chip) which has a quad ARM Cortex-A53 processor with a maximum clock speed of 1200 MHz. The computer has 1GB LPDDR RAM, running at 900 MHz. Part of the RAM is shared with the GPU (Graphics Processing Unit). The GPU is Broadcom VideoCore IV. The computer has four USB 2.0 ports (one port is used for Ethernet connection).

This version of Raspberry PI has capability of wireless communication over 2.4 GHz 802.11n, and also Bluetooth 4.1 classic and Bluetooth Low Energy wireless communication.

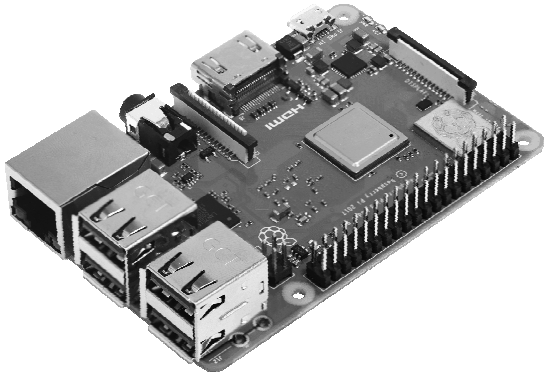

Fig. 4. Raspberry Pi 3 model B

On Raspberry Pi 3, Microsoft Windows 10 IoT operating system is installed. An application that communicates with the microcontroller sensor board and the local (and cloud) database, was developed using Microsoft Visual Studio 2015 in C# language, using the .NET 4.5 framework. The Windows 10 IoT platform was selected to take advantage of the .NET framework and know-how in C#.

On the other hand there is a sensor unit controlled by Atmel Atmega32 microcontroller, to which sensors are connected. It is possible to connect two sensor types, analog and digital, to the sensor unit. Values from analog sensors are read through the A/D converter on the microcontroller itself and the value with digital sensors is read through digital communication (I2C, 1-wire and SPI). The measurement range is defined for each of the analog sensors and if the measured value outside of the range, the corresponding error for the given sensor is sent. For digital sensors the same principle applies, which is the extent of measurement. In addition, some digital sensors offer the possibility of sensor's auto-diagnostics.

The following sensors were used for the experiment:

- Temperature and humidity of the air,
- Temperature and humidity of the soil.

After the measurement and diagnostics of the sensor, the sensor board unit sends the data to the central unit in the following format:

FE A.A | B.B | C.C | D.D | I | J | K | L | FF

FE – start of message;

A.A – air temperature;

B.B – air humidity;

C.C – soil temperature;

D.D – soil humidity 2;

I, J, K, L – the status of the appropriate sensors (0 - if everything is correct and if the value is different from zero there was an error);

FF – end of message.

All values of temperature and humidity for air and soil, which are measured, are then sent, in hexadecimal format, via Bluetooth communication.

Development of web service was done using php and MySQL database. MySQL database can be accessed through the REST service. The service implements all standard operations over a database called CRUD (Create Read Update Delete). REST service accepts and returns JSON (Java Script Object Notation) objects.

The developed database consists of one table, where columns are: column ID, measured data from sensors (air temperature, air humidity, soil temperature and soil humidity) and the measurement time. Data in the database can be loaded as individual measurement or as a set of individual measurements (bulk inserts). Also, data from the database can be taken as a single record (individual measurement). It is possible to download the entire table or as measurements within a given period of time. REST service allows pagination in case the service needs to return a large number of records.

All components of developed solution, central unit with peripheral devices, microcontroller sensor board with sensors and a web service, enable users to easily access all measured data, in order to determine micro-climate conditions in orchard, which are protected by exclusion net.

4. CONCLUSIONS

Netting of orchards change the orchard environment. Some of these changes may be beneficial and others may be damaging.

Advantages of orchard netting are that: harvesting season begins earlier when orchard has nets, fruit quality is improved, management of orchard is improved and netting provide chemical-free control of some orchard pests.

Disadvantages of orchard netting are: high capital cost and in some cases, returns may not justify the expenditure, pollination where in some cases, where are used nets with small holes, access of bees and other pollinators can be limited or in worst case excluded.

In the netting is used to protect orchards from weather conditions or pests, agricultural producers must have in mind that micro-climate conditions in orchards will be changed.

Developed IoT solution for monitoring micro-climate conditions in orchard enable collected data to be available for analysis by agricultural producers, buyers, sellers, scientific institutions and state authorities. First results/ measurements after implementation of IoT solution in orchard, indicate that exclusion netting has different influence on micro-climate conditions to hail netting, which is in most cases used in Serbia.

Future research will be focused in determining precise influence of netting to air and soil in orchards (temperature, humidity). After that it is planned to add light sensor and wind speed sensor for thorough analysis of micro-climate conditions. Final goal is to define algorithm for making decision to net or not to net orchards and if yes with what kind of nets concerning advantages and disadvantages and changed micro-climate conditions.

5. ACKNOWLEDGEMENTS

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The effect of Nutrient Supply on the Decorative Value of Petunia

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Abstract

One of the most excellent ornamental plants of the balcony boxes and hanging cages is petunia. In the Hungarian climate intensive care of it is resulted with magnificent flower flood.A loose, N-poor soil, with medium nutrient supply is preferred, and application of complex fertilizer in 10-14 days is offered to maintain optimal nutrient levels. During the experiment, we used the blue flower Petunia hybrid WFL® 'Bingo® Blue' variety of the German PAC Elsner breeding company. The nutrient supply was carried out with a 2.4 mS/cm EC solution of Volldünger fertilizer and a FitoHorm 24 Mg magnesium medium in a 1.5% solution as a leaf fertilizer. During our research we measured the effect of nutrient supply on decorative value of the plants: plant height, number of shoots and number of flowers.

Keywords: Petunia hybrids 'Bingo ® Blue', FitoHorm 24 Mg, plant height, number of shoots, number of flowers

1. INTRODUCTION

The main decorative value of annual ornamental plants is intense, varied color and habit.[1]

In the selection of annuals and balconies, the petunia occupy a prominent position, the market of petunia is developing [2]. The largest variety of balcony plants can be reached from a number of petunia varieties [3]. Previously, long-lasting balcony plants were fashionable, though in the last years, breeding companies place emphasis on the development of upwards growing, bulky and economically sustainable crops [4]. Selections of the recent years have resulted in incredible color and form richness, coupled with a variety of growth and flowering abilities.

Variety tested by Nébih and certified as GMO-free in the Bingo series: WFL 'Bingo® Blue', WFL ’Bingo® Magma Red’, WFL ’Bingo® Peachy Keen’, WFL ’Bingo® Purple’, WFL ’Bingo® White’ [5]. At Plant Alliance Hungary, 12 varieties of the Bingo variety series of Petunia hybrids are grown: ’Bingo Magma Red’, ’Bingo Orange’, ’Bingo Peachy Keen’, ’Bingo Pink’, ’Bingo Pink Morn’, ’Bingo Blue’, ’Bingo Purple’, ’Bingo White’, ’Bingo Yellow’, ’Bingo Coral’, ’Bingo Rose’, és a ’Bingo Red’[6].

Balcony petunias require loose, good water-permeable medium. Iron deficiency soon causes chlorotic symptoms. Favorable iron absorption is best achieved in pH = 5. Do not add N-overweight fertilizers, otherwise the longitudinal growth of the shoots will be too strong. Keep the soil evenly damp [7], [8]. Nutrient solution among 0.8 to 1.2 EC is optimal [9].

The Klasmann TS 4 medium + clay mixture contains 1 g / liter of PG mix, suitable for rooting and cultivating plants. The medium maintains its loose and airy structure even during intensive irrigation and nutrient supply, so it can be used as a soil of plants held in pots, balconies and amphorae pots [10].

Magnesium is a very important plant nutrient, participates in photosynthesis, in the

biosynthesis of amino acids and proteins, in the energy balance, in maintaining the cation balance, in the development of resistance to diseases [11], [12]. The proper Mg supply protects the plants from intensive radiation [13]. For petunias, getting iron-enriched nutrient supply in a large bowl, it is easier to bear the hot summer days [14].

2. METHODS AND MATERIALS USED FOR RESEARCH

Our research work was carried out in Kecskemét, in a Primor-1 type greenhouse of the Faculty of Horticulture and Rural Development of the John von Neumann University. During the experiment, the PUN Elsner breeding company's Petunia hybrids were used: a blue flowering WFL® 'Bingo ® Blue Impr.' (Figure 1), which is blue floral, early bloom, habitus upward and a moderate growth variety [15].

Fig. 1.Petunia cuttings rooted in paper cylinders

Cuttings rooted in paper rolls were planted on 14 March 2017 into 9 cm diameter pots, the TS 4 medium plus clay type media purchased by Klasmann Company (Figure 2).

The mixture is medium-sized decomposed white peat mixture (0-25 mm white peat + white peat fiber + 10 to 25 mm white peat bricks) with 20 kg / m3 clay granules, wetting additives and added nutrients (140 mg / l N, 100 mg / l P_2O_5, 180 mg / l K_2O, 100 mg / L Mg + trace elements). The nutrient supply was made by a 2.4 mS / cm (EC) solution of fertilizer Volldünger Linz (14-7-21 + 1% Mg + 1% microelements: B, Cu, Mn, Fe, Zn) until the sale (end of May) week. A part of the stock was treated with a 1.5% solution of FitoHorm 24 Mg magnesium medium (6.6% MgO + 18% SO_3) as a foliar fertilizer from April 4th weekly, a total of five times. In our research, the effect of FitoHorm 24 Mg magnesium media on ornamental value was investigated. We compared the treated and untreated plants regarding the beginning of flowering time, flower number, plant height and number of shoots. The measured data were recorded and evaluated by mathematical calculation via Microsoft Excel program. At the end of the growing season, a leaf analysis was carried out at the Soil and Plant Testing Laboratory of the Faculty. About 50 leaves were washed and dried at 70 °C in a drying oven. Air-dry samples were homogenized. Powdered samples were prepared for elemental analytical assays in the presence of concentrated nitric acid and hydrogen peroxide by microwave digestion (Milestone Ethos Plus). P, K, Ca and Mg were analyzed with the ICP-AES spectrometer type Ultima 2. Kjeldahl nitrogen content was measured after sulfuric acidic destruction in FOSS Kjeltec 2300 instrument. The content of the elements (N, P, K, Ca, Mg) was given in m/m% air dry matter.

Fig. 2. Growing of petunia in pots

3. RESULTS AND ACHIEVEMENTS

3.1. The effect of leaf fertilizer on flowering time

According to our observations, the effect of leaf fertilization on the beginning of flourishing time was not significant, but the treated stock flourished few days earlier than the untreated plants.

3.2. The effect of leaf fertilizer on the number of flowers

Figure 3 illustrates the value of the average flower number of plants. As can be seen in the figure, the treated stock had more flowers than the untreated.

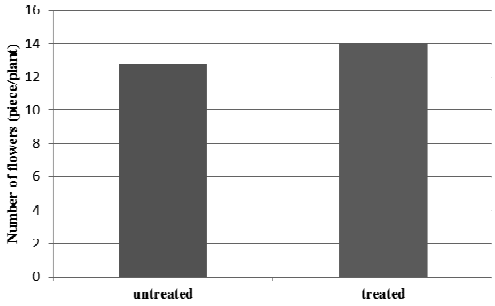

Fig. 3. The effect of leaf fertilizer on the number of flowers (22.05.2017)

3.3. The effect of leaf fertilizer on plant height

Figure 4 illustrates the average height of the plants. The plants in the treated stock were higher than the untreated ones, but the difference in the growth was negligible.

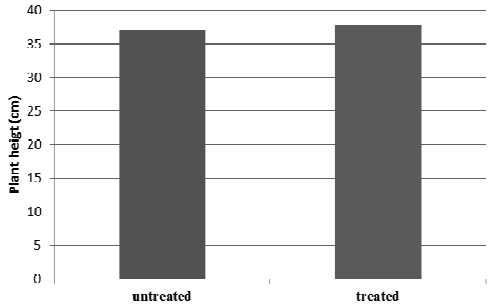

Fig. 4. Impact of leaf fertilizer on plant height (22.05.2017)

3.4. Effect of leaf fertilizer on the number of shoots of plants

Figure 5 illustrates the average number of shoots of plants, from which it can be seen that the number of plants in the treated stock was more than in the untreated plants.

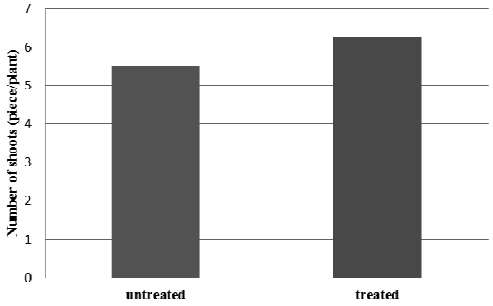

Fig. 5. Effects of leaf fertilizer on the number of shoots (22.05.2017)

3.5. Effect of leaf fertilizer on the nutrient content in the leaf plate

The results of the leaf analysis are shown in Table 1. The nutrient content of the leaves demonstrate the positive effect of leaf fertilization, as the leaves of the treated stock have higher levels of nitrogen, phosphorus, potassium, calcium and magnesium compared to the untreated controls.

Table 1. Leaf analysis of Petunia hybrids WFL® 'Bingo ® Blue Imp.'

Nutrient	Unit	Untreated	Treated
Nitrogen	m/m % air-dry matter.	3.19	3.21
Phosphorus	m/m % air-dry matter.	0.706	0.800
Potassium	m/m % air-dry matter.	3.63	3.68
Calcium	m/m % air-dry matter.	2.72	2.88
Magnesium	m/m % air-dry matter.	0.312	0.330

4. CONCLUSIONS

Magnesium is an important building element of chlorophyll and plays a basic role in plant life. Based on our research we can conclude that FitoHorm 24 Mg magnesium leaf fertilizer had a positive effect on the flowering time of petunia, the number of flowers, plant height and number of shoots (Figure 6). It was shown, that the use of the fertilizer resulted higher macro- and meso-element content in leaves as well. Of the examined parameters, the positive effects in the treated plants on the flower and shoot numbers were probably due to the foliar fertilizer. These results are preliminary research results, so there is a need for further testing.

Fig. 6. Petunia hybrids WFL® 'Bingo® Blue Impr.' before sale (22.05.2017)

5. ACKNOWLEDGEMENTS

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Investigation of Some Soil Physical Parameters of the New Plantations in the South-Eastern Part of Hungary

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Abstract

The rural development and agricultural EU grants help to promote the competitiveness of the agricultural activities. Plantation grants take great interest in the south-eastern part of Hungary. Farmers need to make soil tests before plantation of fruit and grape. Making soil physical tests and the required analysis of the test results help the farmers work efficiently and contribute to the realization of economical and environmentally friendly activities. In our present study, we investigated the distribution of some of the most important physical properties of the soil in the planned vineyards. We followed the frequency of occurrences of their risky values and the correlations among the parameters. The results of the soil tests show some strong relationships between the determined physical parameters.

Keywords: plantation, vineyard, soil tests, lime content, organic matter.

1. INTRODUCTION

Creation of new vine and fruit plantations is a major professional, and long term task in horticultural growing. Making soil physical tests and the required analysis of the test results help the farmers work efficiently and contribute to the realization of economical and environmentally friendly activities. In our study we evaluated the results of some soil tests and the main relationships among the most important physical parameters of the examined soil samples.

In our earlier study we showed the distribution, size and type of plantations in our region in a five-year time period [1]. We showed that most new plantations were vineyards in our region. The ratio of fruit tree orchards in plantations was the highest in 2013. The average area of the planned fruit gardens was about 33% greater than that of vineyards [1].

In the fruit and vegetable framework of the EU program, supports can be granted to supplementary planting operations, changes in the breed structure of plantations, re-plantation for modernization purposes and to the establishment of new plantations in orchards and vineyards. Support for the plantation and replantation of orchards is supported exclusively under the Rural Development Programme. EU grants supported plantation of vineyards and orchards in Hungary as well, and farmers made efforts to use modern innovation and economic growing technics in these areas. Hungary is a rural country, about two-third of its area is classified as rural. Rural Development Programme for Hungary promotes preserving and enhancing of the economic growing methods in agriculture. Hungary's geographic and climatic characteristics provide excellent opportunities for quality fruit and grape growing and consumption. The southern part of the Great

Hungarian Plain is the largest horticultural area of the country.

Common Agricultural Policy of the European Union promotes farming practices that support soil conservation and maintenance [2]. There is a continuous need for monitoring of the soil quality and technical methods aimed at the optimization of soil protection. Our aim was to follow if the areas were adequate for the establishment of vineyards on the base of the results of some soil tests.

Among the soil physical parameters soluble salt concentration is in great interest. Soil salinization may be a frequent problem in Europe. It may be caused by the use large amount of inorganic fertilizers and soil conditioner compounds. The accumulation of soluble salts in the soils may be a result of inadequate irrigation technique, including the use of saline water or poor drainage conditions [3]. The thresholds and baselines of salt concentrations used to assess salinization are well defined and almost universally accepted. Some composition of the irrigation water in our region was described in our other studies [4]

In sandy soils, the use of very high doses of nitrogen fertilizer often occurs. Occasional over-watering or large amounts of biomass left on the fields may contribute to the undesirable load of the environment.

In our study we followed some physical characteristic of the soils of the planned new plantations in the south-eastern part of Hungary and followed the relationships between the individual physical characteristics.

2. METHODS AND MATERIALS USED FOR RESEARCH

2.1. Collection of soil samples.

The collection of the soil samples took place from 2009 and 2016 in the south-eastern part of the country, mainly in the Danube-Tisza Interfluve, and dominantly in Bcs-Kiskun County. The collection of soil samples have been done by registered experts of soil protection, being in relationship with the Soil and Plant Testing Laboratory of the Faculty. Soil samples were taken in the planned plantation fields of the farmers, from soil segments in different depths (0-150 cm) and topsoils (largely 0-30 and 30-60 cm; and 0-20 and 20-40 cm depths in the case of berries). The test results of 2840-3150 samples were processed in this period for each examined parameters.

2.2. Analytical methods and statistics

Analytical testing methods were made in the Soil and Plant Testing Laboratory of Faculty of Horticulture and Rural Development, John von Neumann University (Kecskemét) and in the predecessor institutions (Pallasz Athéné University and Kecskemét College Faculty of Horticulture).. Laboratory continuously uses standard methods involved in the accreditation certificate (NAT-1-1548/2011 and 2015). Standard analytical methods were used for the measurement of the commonly used physical parameters. Water-soluble salt content was estimated by electrical conductivity of the soil, filled up with water, and using the data table of the standard description (MSZ-08-0206-2:1978). Lime content was expressed in m/m% calcium carbonate. $CaCO_3$ content of air-dry samples was determined after reaction with 10 m/V% hydrochloride solution in calcimeter (Labsystem). pH was measured in two ways: in 1:2.5 aqueous soil suspension and in 1:2.5 1 mol/dm^3 potassium-chloride suspension after 16 hours storage.

Statistical analysis and demonstration of data were performed by Microsoft office excel program. Average levels, standard deviation and correlation coefficients (Pearson's r value) were estimated. Statistically significant differences were determined in 5%, 1% and 0.1% levels [5].

3. RESULTS AND ACHIEVEMENTS

The dominant plantations in our region were vineyards, except in 2012. In this year the total

planted area was the smallest in the examined time interval, which was resulted from the lack of the plantations of vineyards. The result of soluble salt determination is shown on Figure 1. Our soil samples showed low salt concentrations. Soluble salt levels in the soil aqueous solution were under 0.02 m/m%, in three quarters of samples. Soluble salt concentration were in the 0.06-0.10 m/,% range in the 1.7% of samples, while it was above 0.10 m/m% in negligible manner (<0.2%). Soluble ion concentration did not exceed 0.15 m/m% level in any cases.

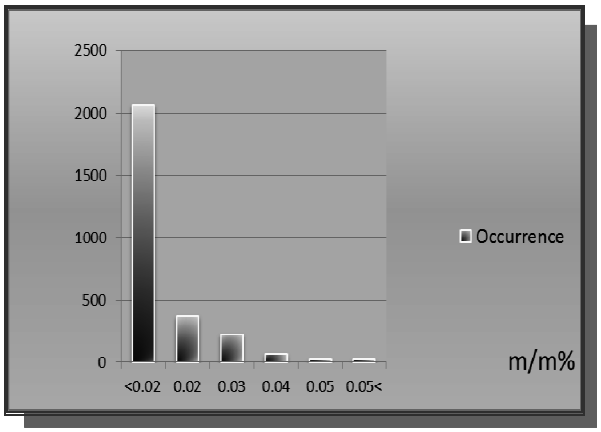

Fig. 1. Occurrence of the different soluble salt concentration levels in the soil

Calcium carbonate content of the soil is very important factor in structure stabilization and pH maintaining of the soil. The distribution of lime content is shown in Figure 2.

As shown in Figure 2, most of the samples showed calcium carbonate content in the 1-7 m/m% concentration range, representing mildly calcareous soil properties. In about 3.5% of the samples $CaCO_3$ content was higher than 20 m/m%, and in 2.1% it was higher than 25 m/m%. In 8.6% of the samples lime content was lower than 1 m/m%.

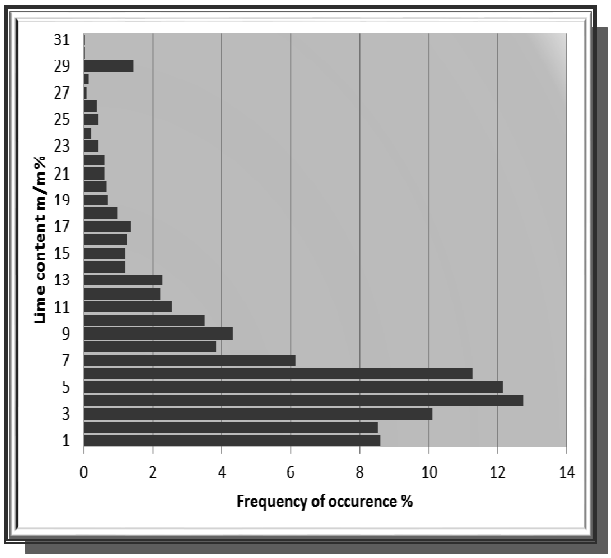

Fig. 2. Frequency of the occurrence of the different lime content levels in the soil

As shown in Figure 2., calcium carbonate content showed a wide range of distribution in our samples. The average concentration was 6.24 m/,% with 5.31 m/m% standard deviation.

The number of the tested was significant. We followed the correlation between some physical parameters as well (Table 1.). Lime content was in strong positive correlation with the alkalinity of the soil. We showed strong positive correlation between lime content and pH measured in aqueous solution, in 0.1% significance level (r=0.443). Similarly, pH measured in KCl solution was strongly correlated with lime content (r= 0.343; p<0.1 level). Lime content was not related with soluble salt content (r=-0.080, p>0.05) There were no statistically significant differences

Table 1. Correlation coefficients between some physical parameters in the soil samples

	$pH(H_2O)$	pH(KCl)	Soluble salt	$CaCO_3$
$pH(H_2O)$	1	0.839***	-0.431***	0,443***
pH(KCl)	0.839***	1	-0.441***	0.343***
Soluble salt	-0.431***	-0.441***	1	- 0.080
$CaCO_3$	0.443***	0.343***	-0.080	1

****p<0.001 significance level*

4. CONCLUSIONS

Planting and modernization of plantations is supported in Hungary, which means installation of new plantations and modernization of the existing plantations e.g. with making the possibility of irrigation and hail damage avoiding. Soil texture in the south-eastern part of Hungary, and mainly in Bacs-Kiskun County, with large area of sandy soils, is very suitable for growing vineyards. Grape is not a nutrient demanding plant in usual, so many varieties grows efficiently in soils with poor nutrient supply. Soil physical and chemical characteristics are very important for planning vineyards and orchards, so soil parameters should be determined before planting. The results of our study confirmed that soils showed low soluble salt content, the average level was about 0.02 m/m%. It shows that our soils are not risked regarding high salt loading. Soluble salt content never exceeded 0.15 m/m% level. This very favorite result shows that soils in the examined area were not contaminated in significant manner. In EU, there remains a need for soil monitoring networks and decision-support systems aimed at optimization of soil quality in the region. As the pressure on European soils seems to continue in the next decades, clearly defined regulatory frameworks and regulation is needed [2]. In usual, a sandy loam or gravelly soil is considered the best for grapes, but they can grow on many type soils [6]. The soil should have a fairly high water-holding capacity, not be waterlogged at any time during the year [7, 8].

Solis in the tested area had moderate $CaCO_3$ contents. Lime content in the soil help to stabilize soil structure and pH. Calcareous soils are frequent in our region. Lime content was in strong positive correlation with pH (measured both in aqueous and KCl solution), while it was not related with soluble salt content. The large number of samples emphasizes the role of (re)plantations in our region. The size of the tested area was closely 1900 ha among 2009 and 2016.

Natural and environmentally friendly land use and agricultural farming methods are promoted and regulated in Hungary. Optimizing of grape and fruit growing technology including fertilization, more effective organic waste use, plant protection and irrigation are all important from both economical and environmental points of view [9, 10]. These efforts influence most of the physical, chemical and biological processes in the soil. Greater scientific knowledge is critical to avoid soil loss problems [11]. Soil degradation must be avoided. Soil Thematic Strategy of EU is addressed to the management of soils, soil monitoring and harmonization of the soil data [12]. Developing cost/benefit analysis and multi-actor approaches to soil protection strategies in EU is promising.

Our result data emphasize the importance of the fact that the quality of the soil should be monitored before planting, and regularly controlled thereafter.

5. ACKNOWLEDGEMENTS

The authors wish to thank to our colleagues in the testing laboratory for the expert technical assistance. This research is supported by EFOP-3.6.1-16-2016-00006 "The development and enhancement of the research potential at John von Neumann University" project. The Project is supported by the Hungarian Government and co-financed by the European Social Fund.

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Local Effects of Climate Change on the Sand Dunes of Hungary

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Abstract

Global climate change is endangering today's and even more so future generations' living conditions. In our work, we examine climate change in Hungary, projecting it onto agriculture where extreme weather conditions are most noticeable. As a testing area, we chose the Hungarian Sand Dunes (Homokhátság) area because of the diversified agricultural production here and because this part of the country is the most affected by climate change. The Homokhátság occupies a significant part of Hungary and has always been a major agricultural production center. The homestead farms established here define the image of the Hungarian Great Plain. Preserving them has recently become a key issue. The preservation and development of this form of farming is indispensable for sustainable landscaping. In the area threatened by climate extremes negative impacts are even more pronounced causing numerous losses. Interviews with local farmers provide an overview of the impacts of climate change and measures taken to mitigate the expected and future damages in the farms surveyed.

Keywords: climate change, farm management, mitigation steps

1. INTRODUCTION

Climate change and global warming are often used as synonyms nowadays, as these concepts have a cause and effect relationship. Both phrases are correct, as both refer to the changes in climatic factors. The fundamental difference is that while climate change mainly describes natural processes, global warming primarily focuses on man-made changes [1]. Climate change is a natural process in which the warming and cooling periods cyclically follow each other [2]. Human activity, in particular, has caused global warming which by no means can be classified as a natural process. Due to the intensive use of fossil fuels (coal, crude oil and natural gas) - since the beginning of the industrial revolution - the atmosphere of our planet is warming which by now has resulted in dramatic consequences [3]. Due to global warming the arctic ice is melting, causing seawater levels to rise resulting in changes in the soil structure which will result in increased soil erosion. Rising water levels increase evaporation which in turn will change weather patterns. This results in a worldwide increase in the formation of extreme storms, rising strength hurricanes and hectic cyclones. In the wake of these storms, an abundant amount of rainfall suddenly leads to devastating floods and soil erosion. [4]. The complexity of the problem is stemming from the fact that climate change is affecting all countries of the Earth, thus it is insufficient to address the issue only on a local or national level. This is means major problems not only for food production, water management and energy generation, but also creates political and health issues. As a consequence, there is significant migration from certain desertified areas to more advanced European countries, causing social and political tensions [5]. Agriculture is the most vulnerable sector to climate change, mainly due to declining production yields and harvest failures. The

precipitation-poor weather and the shift in its timing and its unpredictability represent an increased irrigation task [6]. Agricultural crops produced through traditional farming methods no longer produce acceptable quantities of and quality which requires the development and application of new drought-tolerant species. This increases cost which is immediately reflected in the price of the produce. In higher winter temperatures parasites are able to hibernate and protection against them requires additional costs in the next cycle of production [7]. The effects of climate change are also strongly felt in Hungary. It is projected that global warming will result in frost damage, wind storms, forest fires, and flooding due to sudden large amounts of rainfall [8]. In Hungary, further drying of summer will undermine the chances of crop production, the main problem being the replenishment of water supply. The positive effects of the increased number of sunny hours cannot be utilized due to the low precipitation and can even cause serious damage. The usage of water is considerably increasing during heat waves, however due to the decreasing precipitation and increasing evaporation the amount of water needed will become harder to cover. During drought periods the moisture of the soil is reduced which additionally also results in the sinking of groundwater levels [9].

In our work, we do not aim to examine the path leading to these changes, but rather the adaptation to the situation already presented.

2. METHODS AND MATERIALS

2.1. Characteristics of the Sand Dunes area

The Homokhátság in Hungary is situated on the plains of the Danube-Tisza interfluve, covering an area of almost 10,000 square kilometers, at an altitude of 80-140 meters. The Homokhátság includes around 15 micro-regions and about 104 settlements (Figure 1).

As a consequence of deforestation, the amount of cultivated and grazing areas grew, however it has also contributed to the erosion of the soil surface. The other significant soil-forming factor was the regulation of rivers which resulted in a completely different landscape of the Great Plain and its water conditions. The combined effects of soil and climate change over the decades have already created serious problems for the water supply of the area. The effect of global warming is most felt here. The changing climate takes on Mediterranean features causing the summers to become warmer and drier, so that the land started to dry up and to rapidly lose its water reserves. Most of the area is located on sandy soils, and there are also alkaline, meadow and forest soils. Thanks to the mainly sandy soil, the water absorption capacity of the area is great but the water storage and water retention capacity is very poor.

Fig. 1. The area of the Sand Dunes

The alkaline areas of the Homokhátság are inadequate for agricultural cultivation due to their high salt content. Homesteading is typical of the Sand Dunes area. The number of homesteads with agricultural function decreases from time to time. This way of life is less attractive to young people. Another reason is the current poor profitability of agriculture in this area. Nonetheless, nearly half of the homestead farms still have an agricultural function within which small-scale production is typical.

2.2. Methods

Based on secondary research, we continued our primary research through conducting interviews. We have questioned farmers on the effects of climate change in personal meetings. We have strived to get answers from the most

prominent people. The interview included answering semi-structured questions, but for each question we have also provided an opportunity for respondents to formulate their personal comments in an informal way. We have contacted 42 homesteads with decades-long history that were typically second- and third-generation businesses. They had an established production system so changes in it could be tested effectively. The smallest farms are managed on 3 hectares while the largest on 180 hectares. In particular, arable crop production was characteristic, but significant amount of grape and fruit production was also present, and we have also visited several livestock farms.

The Sand Dunes area is ideal for research in many respects. In Hungary, this is the area that is ranked first in terms of climate sensitivity, and on the other hand, agricultural production in homestead farms has endured in this area.

3. RESULTS AND ACHIEVEMENTS

In our research, we sought answers to a number of questions, from which we only highlight the most important results.

3.1. Assessing climate change in the Sand Dunes area

All respondents are aware of climate change, and we have received unequivocal responses from the experiences of climatic conditions. According to Figure 2, producers have independently classified the same phenomena. The first and most noticeable effect is seen in the change of seasons. It is of special importance that the winter months are mild and often frost-free, affecting next year's production. The aridification process can already be observed in the region, which over time can lead to desertification. The tendency of recent years shows that even during the harvest period significant losses have to be reported due to the uneven distribution of precipitation. This phenomenon often affects winter soil works. According to farmers, the second most frequently observed change is seen in the extremes of weather phenomena. Against the sudden storms that are often accompanied by hail there is simply no possible defence. Hail is now to be expected not only in spring but also early summer. Another consequence of whimsical weather is the sudden, abrupt temperature fluctuation of 10-15 ° C. More than half of the farmers attribute rising temperatures to climate change. Interestingly, it was not the summer heat mentioned first, but the mildness of winters. In terms of rainfall, half of the respondents feel a change in its quantity and unevenness. There are fewer rainfalls in the spring and early summer when it is most needed. Thus, the irrigation periods are getting longer, resulting in significant cost increases. Half of the respondents think that there is a noticeable change in the living world as well. All of them have met with new invasive species appearing in their farms, against which a change in the proven defence methods is needed.

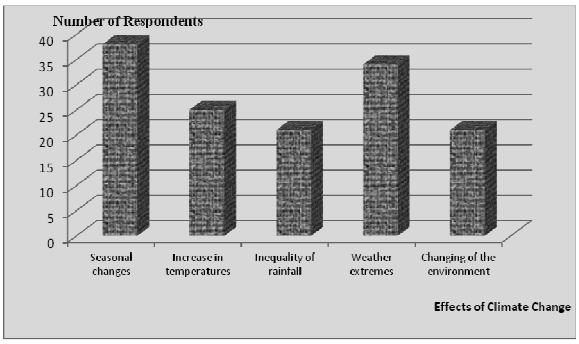

Fig. 2. The effects of climate change

3.2. Effects of climate change on production

Respondents see the effects of climatic change on agriculture mainly in the decline of production yield (Figure 3.). On the one hand, the damage was caused by extreme weather events (storm, hail, etc.) and on the other hand due to heat waves and low precipitation. More than half of the farmers thought the quality deterioration of crops, the proliferation of pests and the decline of water resources were caused by the negative effects of climate change. Only a handful of them thought that the deterioration in soil quality was also the result of these changes.

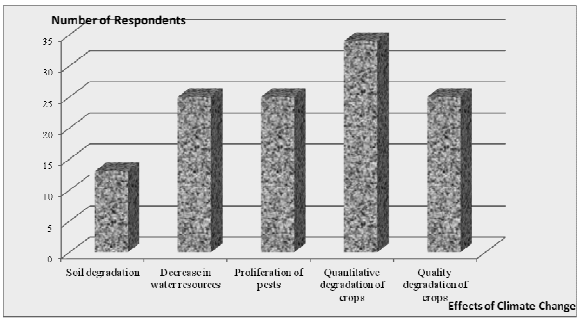

Fig. 3. Effects of climate change on production

3.3. Damages due to adverse weather conditions

The unfavorable weather factors listed above are mainly understood for the summer period. We asked for the last 10 years to be evaluated. Figure 4 shows, that farmers consider heat as well as the drought associated with it to be the worst climatic effect. This is especially a problem in those areas where neither field crops nor vine and fruit plantations have irrigation. Farmers mentioned almost in the same proportion the adverse effects of hail and thunderstorms. The surveyed livestock farmers did not report any significant direct negative effects of the weather phenomena, their effects affected them indirectly.

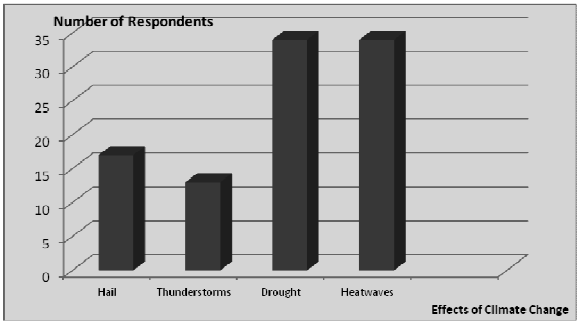

Fig 4. Damages due to adverse weather conditions

3.4. Losses sustained due to climate change

We were especially interested in the adverse effects of natural phenomena caused by climate change. Figure 5 shows that almost every respondent ranked decreasing yields in first place. Among the reasons, mainly aridification (droughts, heatwaves), storms and hail were mentioned. At second place has been the deterioration of quality which results in a serious loss of income. The causes of deterioration in quality are the persistent heat and lack of rainfall. The proliferation of pests associated with climate change and the additional cost of defence are mentioned at about the same frequency. The respondents reported that the defence was made more difficult by the appearance of many new parasites that did not yet have an effective form of protection. The surveyed livestock farmers encounter unknown new species and a significant increase in known pathogens.

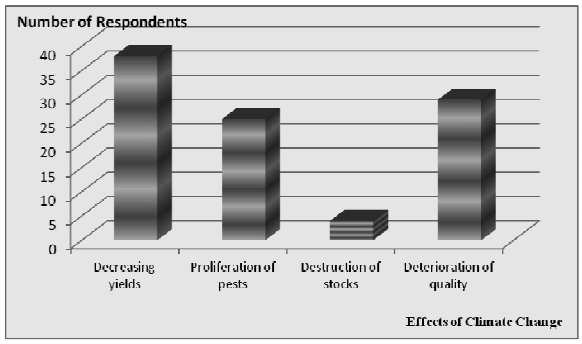

Fig. 5. Losses sustained due to climate change

3.5. Loss mitigation

Our questions were aimed at preventing future damage. All respondents agreed that the costs of prevention could significantly reduce the damage caused by climate change. Figure 6 shows that respondents thought that utilizing new species that are more suitable for droughts, better adapted to the new climate and more resistant to pests would be the most effective. Associated costs of this are much lower than, for example, building an irrigation system. There are very different opinions about irrigation. Crop producers and plantation owners often cannot afford the costs of drilling wells and the construction of irrigation systems even with the help of subsidies. However, farmers engaged in horticulture place great emphasis on irrigation, especially through the modernization of the growing equipment. Expanding the machine fleet is an essential prerequisite for efficient production by all farmers. Here larger landowners have the advantage, while people with smaller land use equipment leasing services. In order to improve the water retention capacity of the soil, producers mainly utilize mulching.

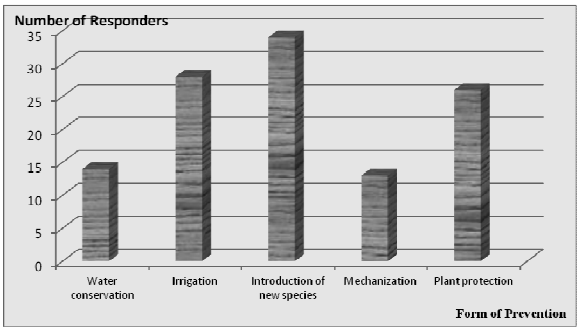

Fig. 6. Forms of prevention

2.6. Forms of support

Farmers have already implemented a number of improvements from their own funds, and they have also taken out loans, but they are having difficulty keeping pace with the rapidly changing conditions. Based on our question "What kind of assistance do you expect in the future" (see Figure 7), most respondents think that primarily monetary support is needed. The extension of the consultancy network is considered by most respondents as important if it comes in the right time. Half of the respondents would like to expand the system of tenders for subsidies and make them more accessible and simplified. The need for education was primarily named by younger farmers.

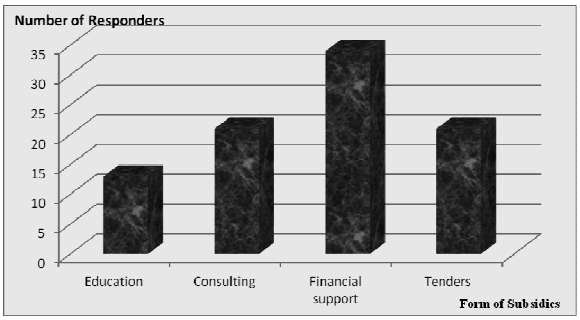

Fig. 7. Forms of support available

4. CONCLUSIONS

Each of the surveyed farmers is aware of climate change and is monitoring its effects. As to the impact of climate change on agriculture, they are mainly focusing on short-term losses. Quantitative and qualitative deterioration of yields has come to the forefront as a result of the degradation of the soil or the decline in water resources. Water conservation, the use of water retention techniques, and sustainable use of water wells could improve the situation. It would be a step in the right direction to capture rainwater, store it and then incorporate it into the irrigation system. Of the weather phenomena, the biggest problem in the region is the heat and the drought associated with it. Farmers' livelihoods depend to a large extent on the extreme weather conditions that are becoming more and more commonplace due to climate change. The losses generated by extreme weather conditions are so high that they already threaten the operations of farms. Farmers are willing to take the steps to prevent damage. Changes are mostly carried out through introduction of new resistant species and protection against pathogens. Water replenishment techniques are not fully agreed on among farmers. As far as subsidies are concerned, the producers are well aware of the opportunities and take advantage of them. They are primarily in need of specific financial support, but there is also a growing demand for knowledge transfer of new methods to mitigate risks.

5. ACKNOWLEDGEMENTS

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Evaluation and Development Opportunities for Short Food Supply Chains in Hungary

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Abstract

In the 2014-2020 EU budget periods, one of the priorities for rural development is the establishment of Short Food Supply Chains which means reducing distance between local producers and local consumers and prioritizing local markets. In our work, we aimed at mapping the place of local producers within the distribution channels and evaluating local producer groups. We were looking at what tender opportunities producers are utilizing that can directly or indirectly link them to the Short Food Chain Program. To this end, we have set up several hypotheses. Firstly, we assumed that the change in consumer habits greatly influences producer's supply. Second, we investigated whether producers choose the sales channel where they can sell at the highest price or where the most products can be sold. Our hypothesis was also that more and more of the local producers are also involved in product processing. The research was conducted via questionnaires, during which 265 forms were filled out at traditional markets and also at cafeterias and restaurants.

Keywords: short food supply chain, producer groups, consumer behavior study

1. INTRODUCTION

Local Food System is a geographically identifiable, regional environmental initiative with socioeconomic characteristics and cultural traditions that creates food self-sufficiency through the relationship between local food producers and consumers [1]. The short supply chain (SSC) expression covers a variety of sales channels. Beside the small geographical, social and cultural distance between the producer and the consumer, a common characteristic is the need for healthy food grown in an environmentally friendly way [2]. Similar to the French definition, the Hungarian position also calls for a specific distance (40 km). In Hungary, the conditions of small-scale food production and sale are governed by the VM 52/2010 (IV.30) decree [3], [4]. In another approach, emphasis should be placed on direct sales when delimiting short food chains [5]. There are three main types of individual direct sales: 'producer does not move', 'consumer does not move' and 'producer and consumer meet in the middle' [6]. Selling to directly to consumers is one of the possibilities for the producer to increase its share of consumer prices, thus excluding some of the intermediaries from distributing the products. For a successful sale, a change of attitude is indispensable: instead of the production orientation that is typical of agriculture, marketing orientation is a priority, in which producers must take into account consumer needs and adapt to [7]. SSCs can be implemented in Hungary as follows. An *open economy* means selling at a farm, a local shop, a village table or through pick constructs. At *sales points*, we mean the farmers market, producer market, festivals, fairs, and farm shops operating in settlements. The SSC can be implemented through home delivery, e.g. with a box system

or with a mobile shop. In the case of short SSC, the producer sells himself or in cooperation with an intermediary (hospitality, catering, food retailing) [8].

The EU's thematic sub-program aims to make the Short Supply Chain in the food sector contribute to a diverse and growing source of income for producers. Help create a closer relationship between producers and consumers by raising awareness of the importance of the agricultural sector to the sustainability of society. Increase fresh, high quality, less processed food supplies at local level to promote healthy eating without causing any additional costs for consumers [9]. SSC is a supply chain formed by a limited number of economic actors committed to cooperation, local economic development and close geographic and social links between producers and consumers [10]. SSC can improve the revenue of producers and ensure the survival of many farms due to greater profit margins and the fact that the farm is less reliant on the food sector. From a cultural and social point of view, they encourage joint decision-making and more self-governance responsive to local needs, and promote and support the preservation of local traditions by linking the product to the geographical area of origin of producers and consumers [11].

The *Hungarian thematic sub-program* seeks to involve few operators in the system who are committed to cooperation, local economic development, close geographic and social links between producers, processors and consumers. The primary objective, however, is to increase the competitiveness of producers by improving their integration into the agri-food chain through quality systems, increasing the added value of agricultural products and promoting local markets and short supply chains, producer groups and professional organizations [12]. In Hungary, farmers participating in short supply chains are typically the smallest (single or micro enterprises). Their self-organizing, advocacy and tender capabilities are weak. Therefore, realizing visible results with this target group can only be achieved by an efficiently separated, clearly understandable and problem-focused thematic subprogram [5].

2. METHODS AND MATERIALS

2.1. Locations of the short supply chain study

The investigations were carried out at local producers, on traditional producers' markets, at catering services and in welfare stores. From local vendors, we included fruit and vegetable producers, animal products producers, beekeepers and winemakers. Since for domestic producers farmers market sales are the most prominent in terms of sales revenue, and this is one of the most popular ways of direct sales, so the interviews were completed mainly at traditional markets, fairs and market halls. We were pleased to find that in some settlements, not only did a local distribution system has been created to encourage self-sustaining, sustainable life, but also efforts were made to familiarize consumers with products thus ensuring that income thus generated remained local. They have developed a local product brand and placed great emphasis on local product development organizations. We also visited those public food service companies that buy local products for their activities: hospitals, restaurants, groceries. We have also asked shoppers in the so-called welfare stores. Here, the buyer can buy at a discount of 30% using a coupon book received from the local government. The small book can be claimed on a need only basis. The owner can use it for one year for purchases of up to 10,000 HUF per month. The shelves have two prices for each product, one is the normal commercial price, which is the same as the supermarket prices. Below this, the 30% a more favourable price is shown.

2.2. Methods

Our research was empirical studies, based on questionnaires and deep interviews. Producers were questioned by means of a questionnaire, and we processed 265 evaluable questionnaires in our work. We got data from public food service companies and welfare stores through

deep interviews. In order to have as many valid questionnaires as possible, 95% of them were made to fill out the forms personally. Almost all sample subjects were willing to help. In addition to the primary data, some secondary data were also taken into account in evaluating the results. The questionnaire used for sampling consisted of 26 questions, consisting mostly of open, closed and some alternative questions. In each of the questions, we also provided the opportunity for respondents to formulate their own personal comments in an informal way. We endeavoured to get answers from the most competent people.

3. RESULTS AND ACHIEVEMENTS

In our research, we sought to answer a number of questions, from which we only highlight the most important results.

3.1. Characteristics of the enterprises in the study

24% of respondents produces on plots under one hectar, almost half of them are between 1 and 5 ha, and 28% of them above this land area (Figure 1). Those with an area below 1 hectare produce vegetables and fruits for their own consumption, and the surplus is sold on the market for supplementary income. Those with a land size over 10 ha are mainly engaged in fruit, grape or arable crops production. 90% of the respondents carry out farming on their own land. Of those that are leasing their plot 66% have at least 50 hectares of land. Among the respondents, 94% of the permanent staff are from the family. Almost half of the farms work with 2 people, and 27% of the farms answered that it is the owner himself that is doing all the work. Dairies employ the most workers.

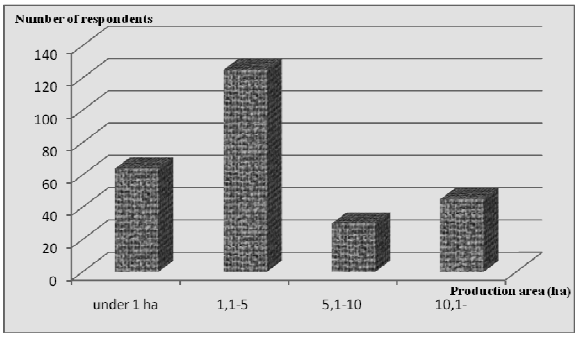

Fig. 1. Production areas

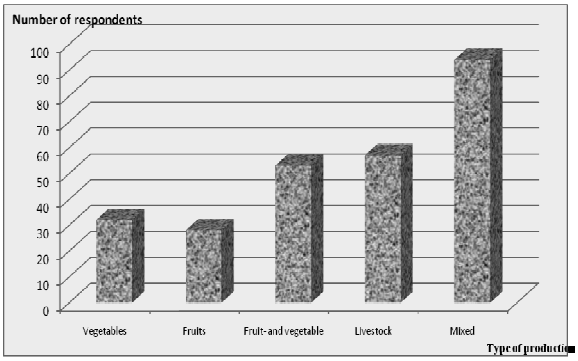

Fig. 2. Production profile

43% of the surveyed producers only deal with crop production, 22% with animal husbandry and 35% in mixed farming (Figure 2). 43% of livestock farmers raise dairy cattle and 28% of them pigs. 41% of respondents sell processed products.

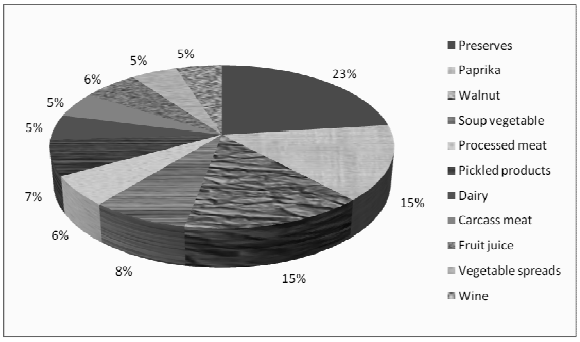

Fig. 3. Food stuff produced

Figure 3 shows the proportion of processed products that are delivered to consumers in the form of direct sales. 26% of the respondents made jam from the fruit produced, mostly without preservatives. Of the processed products examined, 17% sells walnut or paprika powder. One of the new consumer trends is the pre-packaged soup vegetables, sold by 9% of the respondents. Fruit juice ratio is very low, only 6%. Some small-scale family farms produce fashionable health-conscious products such as tubers, baked yam, pumpkin balls, pumpkin salad, pumpkin chips, various sprouted seeds, whole grain spelled wheat or rye flour.

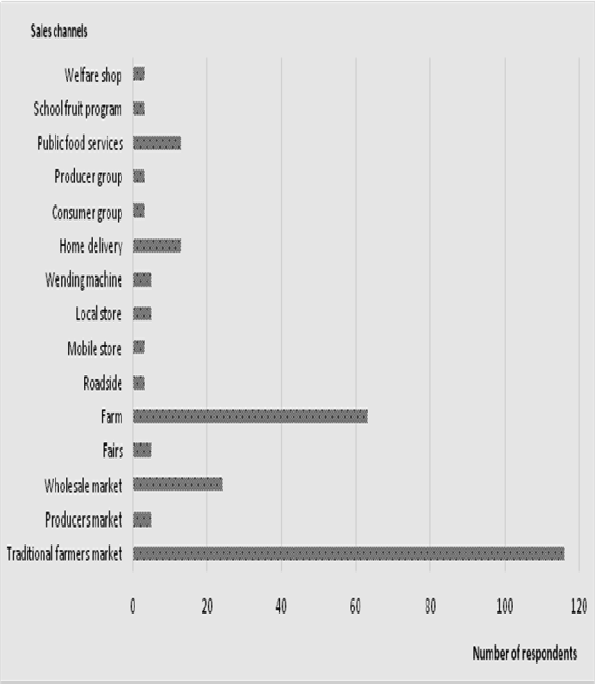

Fig. 4 Sales channels utilized

For the producers, SSC offers a number of sales forms. 44% of respondents sell on traditional markets (one of the main reasons for this high value is that most of the questionnaires were filled out in traditional markets). Sales from their own farms are also very significant (24%). Largest sales occur through wholesale markets, but for this a much larger stock is needed. In case of large-scale production, sales to through producer organizations (TÉSZ) are typical. In the area under investigation selling of raw milk through vending machines is typical, 30% of the milk intended for sale is sold in this form. The automats were placed at a well-established supermarket. Farmers can sell 32% of their production through direct sales to homes, which mainly means milk, smoked meat products and pre-prepared chicken products. Sales of juice in this form are not typical. There is also a special sales form called the box system. The buyer orders pre-arranged boxes to be delivered weekly for a given season, and the producer undertakes to produce the goods and supplies them at a fixed price directly to a home or to distribution points.

3.2. Relationship of SSC and public food services

We have reviewed several hospitals' purchasing assignments. When purchasing raw materials, price is the main determinant, so they cannot think at all on quality. Most raw materials are purchased from wholesalers with whom they already have a well-established connection. It is a great help to them to get the raw materials from one place and having it delivered, saving time and energy. One of the biggest obstacles for the purchase of raw materials is the high price. Mainly potato, apple, beetroot and pumpkin is purchased this way. An additional problem when purchasing in large batches is that the issue of storage is not resolved. These big purchasers are more willing to buy frozen raw materials for easier handling. We also studied the procurement of raw materials in kitchens catering for schools. Based on the in-depth interviews potatoes, green onions, lettuces, apples, juices, pickles, peppers, pumpkin, milk and pasta are the most likely to be purchased through SSCs.

Restaurants are purchasing regularly eggs, meat products, fruit, vegetables, milk, cheese, cottage cheese and honey from the local producers. Those restaurants that want to provide a long-term quality service to their guests buy regularly from a local producer, that is, they are planning for the long run. Those who buy little or no raw materials through SSCs, have either no interest in quality catering (i.e. hospital kitchens) or are struggling to survive, so their decisions are primarily determined by the price. Many have complained that producers are not always able to guarantee the same quality and quantity, and the option of home delivery is missing from their service. Based on our experience, it can also be said that purchasing decisions have a lot to do with management attitudes. Essentially, shopping decisions are based on economic and convenience motivations.

3.3. Attitudes of welfare shop buyers

The attitudes of welfare shop buyers are shown in Figure 5.

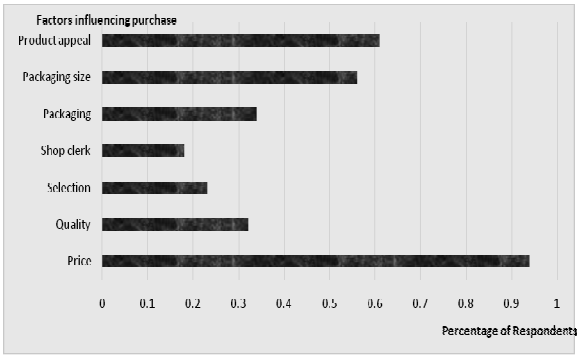

Fig. 5 Opinion of welfare shop consumers

The most important aspect of this customer segment is low price. Relatively important are the packaging size and product appeal which are also closely tied to price. The quality of the product, the server's personality and low assortment does not affect this consumer segment.

4. CONCLUSIONS

Small and wholesale producers are both involved in short supply chains, however, this form of sales is mainly used by small businesses in Hungary. It can be stated that most of the products sold through these channels are of plant origin, especially horticultural products, but the marketing of processed animal products is also becoming increasingly important. Interestingly, fruit juices represent a very small proportion in the SSC. More and more farmers are processing their products thus trying to adapt to the new needs. Hungarian economic and legal changes facilitate this endeavour. Our surveys also reveal the need to broaden the use of SSC channels, which could, among other things, help increase both demand for processed products and willingness to engage in this activity.

Our research reveals that young producers primarily opt for sales channels where they can sell at the highest price or where the most products can be sold. In contrast, older producers often also show emotional investment in their marketing practices. Unfortunately, in many cases, consumers associate farm products with high prices and fluctuating quality, and they are also missing the option of home delivery.

The in-depth interviews show that public catering companies primarily choose products acquired through SSC based on price. At the same time, some caterers regularly buy from local producer as they want to establish long-term clientele through quality service.

5. ACKNOWLEDGEMENTS

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UV-VIS Determination of Polyphenols and Flavonols in Slavonian Propolis

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Abstract

Propolis is one of the most important bee products because of its impact on human health. The chemical composition of propolis is complex and depend on various factors but polyphenols and flavonols, as essential compounds in it, play significant role in the inhibition of certain enzymes, stimulation of hormones, free radical absorbance capacity and helping in disease curing. It is well known that the propolis have many antibacterial, antitumorial, antifungal, antiiflammatory and antiHIV characteristics. It can also be used as local anaesthetic compound. The samples were collected in 2013. UV-VIS determination of polyphenols (with Folin-Ciocalteu reagent) and flavonols (with $AlCl_3$ reagent) in Slavonian propolis showed mutual proportionality and obtained results are comparable with literature. Dry matter content couldn't be directly related to total concentration of polyphenols and flavonols.

Keywords: Agro-Ecology and Organic Farming, UV-VIS spectrophotometry, propolis, polyphenols, flavonols.

1. INTRODUCTION

Polyphenols and flavonols are well known for the inhibition of certain enzymes, stimulation of hormones, free radical absorbance capacity and helping in disease curing. Due to the strong antioxidant activity they possess, polyphenols and flavonols greatly affect the quality and positive effects of propolis on human health. By its origin, propolis is a resinous strain of bushy buds (cane, cucumber, pine, chestnut, birch, etc.) and tree bark that bees in dams use to defend themselves from harmful microorganisms. The bees collect propolis and mix it with the secretion of the jaw glands, enzymatically modified so that the most important constituents, such as polyphenols and flavonols, become pharmacologically active substances. [1-3]

Propolis is the most interesting bee product of firm consistency. It is fragile at a temperature below 15 °C, and at 30 °C is sticky and comes as a substance in the lumps. The colour, chemical composition and taste depend on the origin of the resin that the bees collect and process and move to certain places in the hive. The propolis colour may vary between yellowish (pine), reddish (poplar) and black (birch). Up to date 67 species of plants from which bees collect propolis material are known. [4]

Typical bee communities collect 100 g to 150 g of propolis annually. The most common propolis is that autumn one, because the bees are then preparing for the winter and put propolis in the form of chin on the bottom legs and incase the honeycomb walls. In today's practice, to

increase propolis yields, various wooden or plastic grids are used. They can be cooled and by their bending propolis breaks and in easier and faster way the propolis separates from the grids. In this way, the annual propolis yield is increased and can range from 250 g to 400 g of propolis per heifer. [5]

The chemical composition, aroma and colour of propolis are complex and depend on various factors: geographical zones of collection, time of collection and the type of plants from which it was collected. The colour of the propolis can be from dark green to brow, and the taste may vary from sweet as honey to the brittle bitter taste. [6] Previous research has shown that the propolis contains more than 300 different substances. More detailed analysis has shown that natural propolis contains about 55% vegetable resins and balsams, 30% beeswax, 10% essential and aromatic oils, 5% floral powders and various mechanical primers. [7]

Essential oils and organic propolis components contain phenols of very small molecular weight that are considered to have biologically active properties, namely flavonoids, phenolic acids, esters, aromatic aldehydes and terpenoids. It has been proven that propolis contains up to twelve different flavonoids such as pinocembrin, acacetin, chrysin, routine, catechin, naringenin, galangin, luteolin, cacferol, apigenin, miricetin, quercetin and two phenolic acids; caffeic acid and cinnamic acid and a resveratrol stilbene derivative. [8]

Propolis also contains numerous vitamins: A <10 μg / 100 g propolis, B1 = 1.45 mg / 100 g propolis, B2 = 0.062 mg / 100 g propolis, B6 = 2.25 mg / 100 g propolis, C <1 mg / 100 g propolis, E, nicotinic and pantothenic acid and others. [8] In addition, propolis is rich in provitamin A and carotenoid. Mineral substances in propolis are magnesium (Mg), calcium (Ca), iodine (I), potassium (K), sodium (Na), copper (Cu), zinc (Zn), manganese (Mn) iron (Fe). Zinc (Zn), manganese (Mg) and copper (Cu) and they are very important to our organism because they activate the biological centres of the organism: they activate the process of growth, reproduction and development and participate in the process of creating blood and also have a positive effect on the function of the gland. For example, zinc (Zn) prolongs the action of pancreatic hormone - insulin that sharpens vision. Propolis also possesses various aromatic acids such as benzoic acid, caffeic acid, phenolic carboxylate, etc. [5] It also contains some enzymes such as succinate dehydogenesis, glucose-6-phosphatase, adenosine triphosphatase and phosphate acid. [9]

It is well known that the propolis have many antibacterial, antitumorial, antifungal, antiiflammatory and antiHIV characteristics. It can also be used as local anaesthetic compound. [10-12]

Polyphenols come in various forms and concentrations, depending on the foods and the recommended daily intake is 3-70 mg. [13] The largest source of polyphenols are herbs, more than 8,000 polyphenolic constituents have been discovered in various plant species. Plants primarily serve as molecules involved in the protection from UV radiation or pathogen attack, pigmentation, growth and reproduction. [14] Polyphenols, as secondary metabolites of various plant species, form a large group of chemical compounds that can be classified into several groups with regard to structure and chemical properties. The major groups of polyphenols are: flavonoids, lignans, phenolic acids, stilbene and other phenols, which are divided into smaller subgroups. [15]

Flavonols are yellow coloured polyphenols and are the most widely used flavonoids in food. They are present in the glycoside form associated with the sugar unit, usually glucose and rhamnose, but other sugars (such as galactose, arabinose, xylose) may also be present. Because of the positive effects on health flavonoids are very important part of human nutrition. People with normal diets will inject 1-2 g of flavonoids per day, especially from fruits and vegetables. The bioavailability, metabolism and biological activity of flavonoids depend on

the configuration, the total number of hydroxyl groups and the substitution of functional groups within their nuclear structure. [16]

The aim of this paper is to find out more about Slavonian propolis through its chemical and physical composition and to draw attention to active substances in propolis, such as polyphenols and flavonols that contribute significantly to its quality and ultimately positively affect the health of propolis consumers.

2. METHODS AND MATERIALS USED FOR RESEARCH

Studies were conducted with alcoholic tincture of propolis, which was previously made of propolis lump dissolved in 96% refined ethyl alcohol and purified water. After pouring propolis with refined ethyl alcohol and water, propolis is allowed to settle in a dark bottle with occasional shaking for at least three weeks. After the rest time has elapsed, the propolis is filtered through a filter paper. 20 analysed samples of propolis were collected from the geographic areas of Slavonia, specifically Nova Bukovica and Slatina in 2013.

The following studies were conducted: dry matter content, total polyphenols concentration by UV-VIS spectrophotometric method with Folin-Ciocalteu reagent and total flavonols concentration by UV-VIS spectrophotometric method with aluminium chloride reagent.

Determination of the total dry matter was carried out during drying of the examined samples of alcoholic tincture of propolis in the drying oven. Dissolved 3 g of alcoholic tincture of propolis are placed in a drying oven. The extract was then evaporated to dryness on a water bath and dried in a drying oven at a temperature of 100 °C to 105 °C for 3 hours, then cooled in a desiccator via diphosphorus pentoxide R or anhydrous silica gel and extracted. The results are expressed as a percentage by weight or in g/l. Determination of dry matter was carried out on twenty samples of alcoholic tincture of propolis.

The UV-VIS spectrophotometric method with Folin-Ciocalteu reagent is based on the oxidation reaction (the phenolate ion) - reduction (FC reagent) in the alkaline region, whereby the reaction mixture is the blue liquid tested. Many active propolis components, such as phenolic acids and flavonoids, have a phenolic group and can be evaluated by this method. The total concentration measurement is done using the UV-1800 Shimadzu double-beam spectrophotometer. The supernatant absorbance was measured at λ = 760 nm.

The base of the colorimetric method with $AlCl_3$ is that it forms an acid stable complex with a C-4 keto group or a C-3 or C-5 carboxyl group of flavonols and flavones. $AlCl_3$ produces acid unstable complexes with the O-dihydroxy group in the A or B ring of flavonoids. Compounds with $AlCl_3$ that produce flavonols with C-3 and C-5 hydroxyl groups such as galangin, quercetin, miricetin have a maximum absorbance λ = 415 to 440 nm.

3. RESULTS AND ACHIEVEMENTS

The results obtained by determining total concentrations of polyphenols and flavonols and dry matter content in alcoholic tinctures of propolis are graphically shown in Figure 1. It can be seen from these results that the total concentrations of polyphenols and flavonols are proportional. The dry matter content results in alcoholic tinctures of propolis are different, and there is no always proportionality to the concentration of total polyphenols and flavonols.

The results obtained from experiments on Slavonian propolis are comparable and similar to those in above-mentioned literature, which largely demonstrates the quality of Slavonian propolis

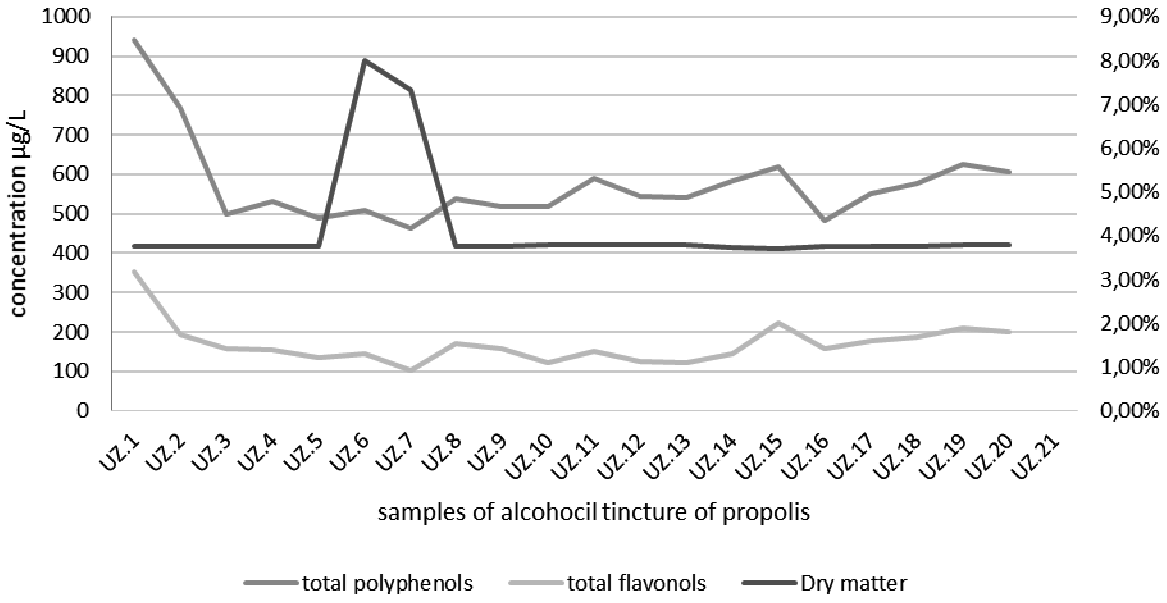

Fig. 1. Concentration of total polyphenols and flavonols and comparison with dry matter in alcoholic tinctures of propolis

4. CONCLUSIONS

This work had aim to find out more about chemical and physical composition of Slavonian propolis and to draw attention to active substances in it, such as polyphenols and flavonols that contribute significantly to its quality and ultimately positively affect the human health. The results obtained by UV-VIS spectrophotometry are total concentrations of polyphenols and flavonols and dry matter content (by drying) in alcoholic tinctures. The total concentrations of polyphenols and flavonols are proportional. The dry matter content results in alcoholic tinctures of propolis are different, and there is no always proportionality to the concentration of total polyphenols and flavonols. The results obtained from experiments on Slavonian propolis are comparable and similar to those in above-mentioned literature, which largely demonstrates the quality of Slavonian propolis.

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Practical Sampling Process for Nematodes Community

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Abstract

The nematode community can reflect soil conditions and they are used as indicators of soil conditions in crops cultivar. For studies, it is necessary to separate nematodes from the environment in which they live their life cycle. Sampling is a process that requires knowledge of the nematodes life cycle, tools for soil sampling, sampling pattern, best sampling time, storage and care of samples. It is necessary to make a proper distribution or sample plan. When sampling it is necessary to pay attention to certain features: crop type and field history, areas planted to different varieties, type of soil, moisture of soil, soil compaction, seasonal changes of clime etc. Sampling pattern is important because of better cumulative representation of the nematode populations at the field. Sampling process have some phases which can affected on inaccuracy such as mixing soil samples, washing samples, analysing samples, taking additional sub-samples and washing and analysing sub-samples. Results inaccuracy can be partly avoided by taking a larger and higher number of samples and sub-samples.

Keywords: methods, sampling, nematodes, soil

1. INTRODUCTION

Nematodes are a group of multicellular organisms belonging to the microfauna of the soil. So far about 26646 species of nematodes are discovered. [1] The nematode community can reflect soil conditions (porosity, texture, chemical composition of soil), climate (temperature, humidity), plant cover (plant species, fertility potential) and organization of production, as well as interrelationships between organisms in soil. [2] Nematodes are used as indicators of soil conditions in crops cultivation [3], in the mechanical disturbance [4], when using pesticides [5], herbicides [6], and fungicides. [7] They also used as indicators of soil in study of influence of various organic mulch [8], in assessing soil quality in conventional and ecological agricultural cultivation [9] in assessment of soil pollution by heavy metals [10] and many other situations.

The nematode attack leads to relatively unspecific symptoms of plant disease (development retardation, chlorosis, etc.) which can easily be attributed to other causes. [11]

For studies, it is necessary to separate nematodes from the environment in which they live their life cycle. Special methods have been designed for this purpose. It is also necessary to make a proper distribution or sample plan of a field where nematodes are studied. A sample plan consists of a collecting pattern, the number of samples comprising that pattern, the number of composite cores in the samples (= size), and the cost of collecting, processing, and counting

the nematodes. [12] For design of the good sampling plan it is important of have some knowledge about variation in space and biology of the nematodes, ass wall as correct choice of tools, sample number and sampling pattern. [13] If it purpose of sampling is qualitative study (taxonomic studies, diagnosis of plant diseases) the accuracy in such cases is relatively low and a simple sampling plan is enough. If it purpose of study is to determinate a nematodes population and the species composition, sampling must be done more accurately. The highest level of accuracy must be done in phytosanitary research as part of legal requirements and inspection regulations. [13]

Sampling is a process that requires knowledge of the nematodes life cycle, tools for soil sampling, sampling pattern, best sampling time, storage and care of samples.

2. SAMPLING

In order to determine which nematodes are present in the soil, a laboratory analysis of samples should be carried out. When sampling it is necessary to pay attention to certain features: crop type and field history, areas planted to different varieties, type of soil, moisture of soil, soil compaction, seasonal changes of clime and temperature, distribution of nematodes on field and seasonal behaviour of the nematode. [14]

Distribution of soil nematodes is clustered and that can create a problem in sampling. Also their vertical or horizontal distribution in soil may cause a problem, because they can be found up to a few metres of depth, depending on crop root, texture of soil and species.

In generally, larger number of nematodes is found in the upper 0 cm - 25 cm of the cultivated soil. [13] If a sample of soil is taken around the tree or orchard, it is necessary to sampling it in the deeper layers of the soil. The sampling depth may be up to 40 cm. [13] Samples are most commonly used from the ground surface layer (10 cm to 20 cm in depth), but if the nematode population is not a concern, then a sample collected through the soil profile to a depth of 20 to 30 cm is probably adequate. [15] Sampling at higher depths is necessary for plants with deeper root and trees. [16]

2.1. Tools for sampling and sampling pattern

Sampling can be taken with different tools depending on the purpose of sampling. Useful tools include: root cutting knife, scissors, shovel, tubes, soil corers or augers, and blade. Collecting tools always needs to be clean and it should be cleaned before taking samples in a separate field. Between sampling clean tools by thoroughly washing with water or disinfecting them with alcohol (70% ethanol).

Figure 1. shows the most commonly used field sampling tools.

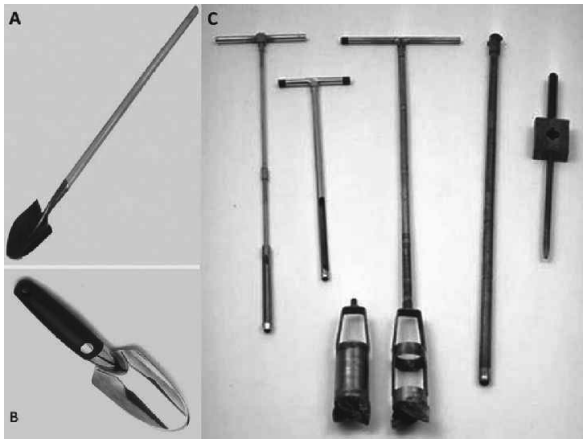

Fig. 1 Shovels and other devices used for collecting soil samples: (A) Classic point-shovel. (B) Hand shovel. (C) From left to right: cylindrical tubes, trowel, tubes, soil corers or augers. [17]

Shovel is good because there are ease to use and quite available, but may cause the temptation to take large samples. Soil can be sampled with a trowel but this method is less reliable than using a cylindrical tubes. A cylindrical tube can be used for sampling at greater depths. Cylindrical tubes are approximately 25 mm in diameter and 300 mm to 450 mm in length. Soil corers or augers are available in a different diameters as well as few different styles designed for different conditions in the soil. Soil corers or augers are often 50 mm to 65 mm in diameters.

Recommendations on size of sampling vary. In order to get the right situation in the field it is necessary to take the sufficient number of samples and sub-samples. For an area of 0.5 ha to 1 ha it is necessary to take minimum of 10 core sub-samples up to 50. [14] Van Bezooijen suggests that the sample consists of 60-70 cores taken at a fixed distance from each other. [13]

Samples should be taken from several pleases on the field and also included the area whit poor growth as well. The number of soil samples is presented in Table 1.

Table 1. Number of soil samples required to estimate nematode populations [18]

Area	Number of soil sample
< 500 m^2	8 - 10
500 m2 - 0.5 ha	25-30
0.5 ha - 2.5 ha	50-60

When taking samples, the sampling pattern is important because of better cumulative representation of the nematode populations at the field.

The samples can be taken systematically or randomly (Fig. 2.). Random sampling plan can only be representative in a small area.

A systematic sampling plan (cores at regular intervals) is often better than random sampling because it gives much more certain results [19] and is easier to apply [12] because it requires less time.

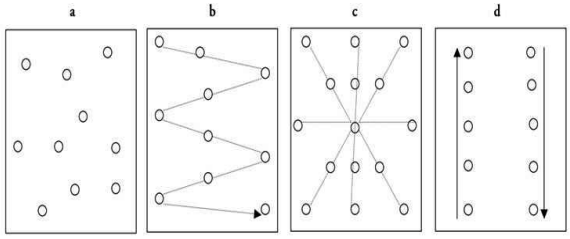

Fig. 2. Sampling patterns. (a) random sampling (b-d) systematic sampling [14]

Sampling pattern for soil depends on the type of crop and the pattern of planting.

For single plants (trees) it is need to collect about ten sub-samples: five near the trunk and five from the dripline (Fig. 3.). [20]

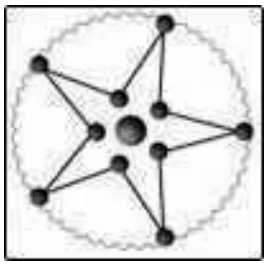

Fig. 3. Sampling pattern for single tree [20]

For row crops is best to collect subsamples from the feeder-root zone within the rows (Fig.4.a.). For solid-seeded crops is best to collect at least 20 subsamples from each four-acre section (Fig. 4.b.). [20]

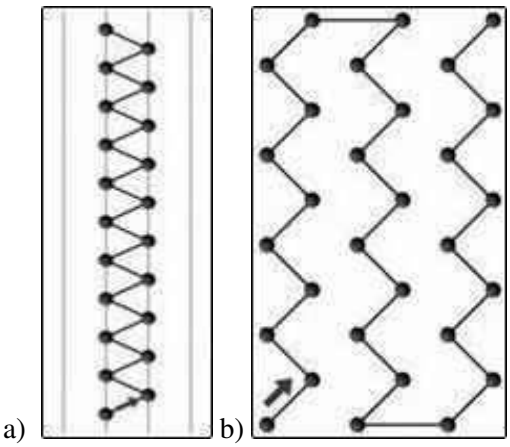

Fig. 4. Sampling pattern a) row crops and b) solid-seeded crops [20]

For perennial plants, collect two subsamples from the dripline of each plant (Fig.5.). [20]

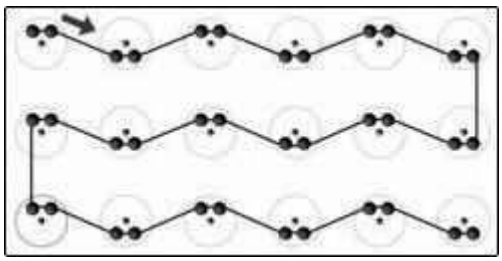

Fig. 5. Sampling pattern for perennial plants (orchards) [20]

The size of a sample can be given as volume (100 ml or 200 ml soil) or in weight (100 g or 200 g of soil) depends of a purpose of research.

2.2. Sampling time

Sampling time often effects on the results obtained so it is necessary to take sample at the

right time. The optimum time varies between field crops and the growth stage of crops, as well as cultivation practices. For the predictive sampling optimum time for sampling is often done early in the season (before planting or at the end of cropping season). [14] For diagnostic sampling it is necessary to collect evidence throughout the season and not just at the end of harvest. To choose the optimum sampling time knowledge of the nematodes life cycle is necessary. For example, many species of nematodes increase in number during the growing season in summer, because of high temperatures and abundant of food as a result of root development. [13, 14] Ectoparasites nematodes species are clustered in the rhizospere, while endoparasites nematodes species are present in the roots and their highest number in the soil is right after the harvest.

2.3. Care and storage of samples

Samples need to be collected and stored in plastic bags to prevent drying. Bags must be label systematically with waterproof marker and identification numbers. Label basic information about samples: name and address of the farmer, sampling date, crop plant and the history of the field (previous crops, fertilisers, pesticides applied), location of the field.

Nematodes are sensitive multicellular organisms and it is very important to take the necessary measures to keep them in good condition after sampling. Samples should not be leave exposed in the field, or in direct sunlight, or in a vehicle. After collection samples must be handled properly and storage in the cool box or boxes and placed it in a cool and dark site. Samples can be stored in a refrigerator for up to fifteen days and their survival decreases over time. [14]. Even for carefully–collected nematode samples, coefficients of variation can be of 50-100%. [21]

3. CONCLUSON

Sampling result is to estimate the nematode number in a field as accurately as possible. Sampling process has some phases witch can affected on inaccuracy such as mixing soil samples, washing samples, analysing samples, taking additional sub-samples and washing and analysing sub-samples. Results inaccuracy can be partly avoided by taking a larger samples and sub-samples and a higher number of them, which provides additional information about field plot and soil.

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Effect of Growing Media on Tagetes Patula Nana Plants Quality

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Abstract

One of the most important conditions needed to be fulfil in Marigold pot-plant production is a selection of apropriate growing medium. The aim of this paper was to determine influence of growing medium on morphological parameters of growth and development of Tagetes patula nana Champion mix. In this experiment substrate for transplants and substrate for ornamental flowers as well as soil were used. The seeds have been plant in containers with 104 cells filled with substrate and with the soil. After developing 4 leaves, 50 plants were transplanted in pots No. 10 in different experimental variants (soil – soil, soil – substrate for ornamental flower, substrate for transplants – soil and substrate for transplants – substrate for ornamental flower). On mature plants these parameters have been measured: number of leaves, above ground plant height, number of side branches, mass of plant above the ground, number of buds and flowers and the diameter of flower. The plants grown in variants substrate for transplants – substrate for ornamental flower showed significantly different ($P \leq 0.01$) in growth performances then grown in variants soil – soil. Also, transplants grown in substrate for transplants developed 4 leaves within 24 days and those in soil developed 4 leaves within 37 days which indicates the influence of growing medium on growth and development of Tagetes from the stage of transplants and importance of growing medium on plant quality.

Keywords: tagetes, growing media, quality

1. INTRODUCTION

Marigold are flower species which cultivation is widely prevalent in city parks [1] and infields (house landscape) [2]. They are also popular flower for cut flower or pot-plant production [3]. French marigold (Tagetes patula) is one of the major sorts as garden plants. Also, among the available marigolds species Tagetes patula (French marigold) have the greatest economic importance [4]. Popularity of Tagetes sp. is a result of their vivid bloom colours and relative small ecological conditions demand [5] and soil [6]. The growing medium have influence on quality of Tagetes sp. in the stage of seedlings [7,8]. In contemporary production of transplants it is necesary to ensure adequate condtions to get highly productive plants which implies choice of adequate growth medium with nutrients and that is not heavy for marigold pot-plant production [9,3]. Substrate enables correct root growth and the development of the abovegrond parts which constitute the plant quality. Evera substrate should have the appropriate physical characteristics, in particular high porosity, high water capacity, durable structure, and availability of nutrients [4]. Composts is usually used for improving of normal plant development especially for ornamental plants which is very depending of growth medium [10]. In the production of greenhouse-grown plants peatmoss is the primary component of substrates [11]. The influence of growth medium on morphological characteristics, as indicators of quality of marigold plants, is the object of investigation many investigators [10,11,2,12,4].

Growth indicators which describe quality of seedlings [13], transplants [14,15] and plants are hight [10] or number of leafs [10,4]. Number of buds and flowers [3,4], diameter of flower [4,16], number of side branches and the mass of plant above the ground, are parameters which can also be used as growth indicators.

Generaly there is no optimal medium for every pot-plants. Materials used for it vary in physical and chemical properties [17]. Increase of hortycultural production of ornamental flowers is based on using ready-made supstrates produced on an industrial scale from single components, mostly divergent combinations of peat on different level of decomposing and origin enriched with mineral fertilizers. These substrates are easy to use and do not require a long period of preparation as a standard garden topsoil [4].

However, pot planting plants are usualy replant in the soils of parks and other open spaces where physical ang chemical characteristics of that soil affects on further plant development. Apart from that, beacause of their popularity in Croatia, those enviromental plants are usualy sow directly in the infield soils. The aim of this study was to determine influence of growing medium on morphological parameters of growth and development of Tagetes patula nana Champion mix from the period of sow through transplants developmnt to the mature plants.

2. METHODS AND MATERIALS USED FOR RESEARCH

Marigold plants has been cultivated in Slavonski Kobaš (Brod – Posavina County) 2018. The seeds of Tagetes patula nana Champion mix with declared germination of 90 % with validity period till December 30, 2021 has been used. The seeds have been sowing April 9, 2018 in containers with 104 cells filled with substrate for transplants and soil. According to declaration (Rp. no. 030) substrate for transplants is fine structure substrate (0 mm - 7 mm), density 100 kg/m^3, total porosity 85 %, $pH_{(H2O)}$ 6, and conductivity (EC) 40 mS/m. It is composed of black sphagnum peat and white sphagnum peat with added fertilizer in quantity of 1.5 g/l. Content of sulfur is 150 mg/l, nitrogen 210 mg/l, phosphorus (P_2O_5) 150 mg/l, potassium (K_2O) 270 mg/l and magnesium (Mg) 100 mg/l. The soil used for sowing and growth is analized according ISO standards: pH reaction (HRN ISO 10390, 2005) [18], concentration of humus (HRN ISO 14235, 1998) [19], contrentration of phosphorus (P_2O_5) and potassium (K_2O) AL-method (Egner et al., 1960) [20], concentration of carbonates (HRN ISO 1069, 1995) [21], soil texture (ISO 11277, 2009) [22]. Results of soil analysis: $pH_{(H2O)}$ 7.36; $pH_{(KCl)}$ 6.41; AL-P_2O_5 8.36 mg/100 g; AL-K_2O 20.11 mg/100 g; humus 2.41 %; $CaCO_3$ 2.09 %; coars sand 0.99 %, fine sand 4.90 %, coars silt 18.01 %, silt 26.28 % and clay 49.82 %. After developing 4 leaves plants were transplanted info plastic pots No. 10 (374 cm^3) in different experiment variants (soil – soil, soil – substrate for ornamental flower, substrate for transplants – soil and substrate for transplants – substrate for ornamental flower). According declaration, using substrate for ornamental flower are all-purpose potting soil with high-absorption clay granules and high water-storage capacity. It is a mixture of poorly decomposing white sphagnum peat, high-quality frozen black sphagnum peat ang clay granulas with added hydrosoluble fertilizer. Total added quantity of fertilizer is in ratio: NPK 14:10:18+ microelements, and $pH_{(H2O)}$ 5.5 – 6.5. On mature plants these parameters have been measured: number of leaves, above ground plant height, number of side branches and, mass of plant above the ground, number of buds and flowers and diameter of flower. The experiment was performed in five replication with 10 plants for each combination. The results have been statistically analyzed by programe package SAS under GLM procedure and ANOVA procedure with applied F and $LSD_{(LSD0.01)}$ test.

3. RESULTS AND DISCUSSION

Analyses of morphological characteristics of plants at 21st day after replanting shows that substrate properties used for transplant and plant growing significantly influence on number of leaves (NL), above ground plant height (HAG), number of side branches (NSB), mass above ground (MAG), number of buds and flowers (NBF) and diameter of flower (DF) (Table 1).

Table 1. Signifficance of growing variants on number of leaves (NL), above ground plant height (APH), number of side branches (NSB), mass above ground (MAG), number of buds and flowers (NBF) and diameter of flower (DF)Tagetes patula

	NL	APH (cm)	NSB	MAG (g)	NBF	DF (cm)
ANOVA F test	250.09	89.14	54.57	161.80	4.09	1.83
P value	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0465

Number of leafes was between 12.62 and 128.2 (Figure 1). Significant influnce of growth variant has been determined ($LSD_{0.01}$ 5.7654). The highest number of leafes had plants in growth variant substrate-substrate (128.2). Less number of leafes had plants in growth variant soil-substrate for ornamental flowers (52.96). Lesser than that was number of leafes in plants i growth variant substrate for transplants-soil (40.36). The least number of leafs was determined in growth variant soil-soil (12.62) (Figure 1).

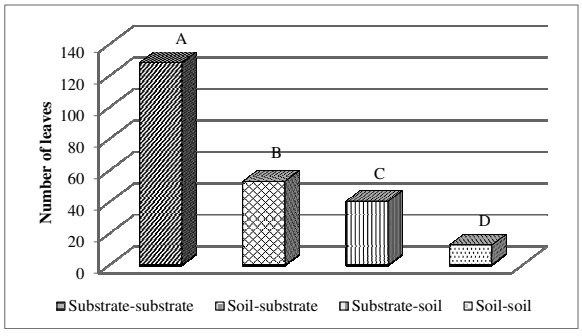

Fig. 1. Number of plants Tagetes patula nana leafes in different growth variants

In addition, above ground plant height plant Marigold (Table 1) was under significant influence of growth variant ($LSD_{0.01}$ 1.6799). The above ground plant height was between 7.61 cm and 28.09 cm (Figure 2). As well as with number of leaves the increase of above ground plant height was determined from variant soil-soil (7.61 cm), soil-substrate for ornamental flowers (14.17 cm), substrate for transplants-soil (17.92 cm) and substrate for transplants-substrate for ornamental flowers (28.09) (Figure 2).

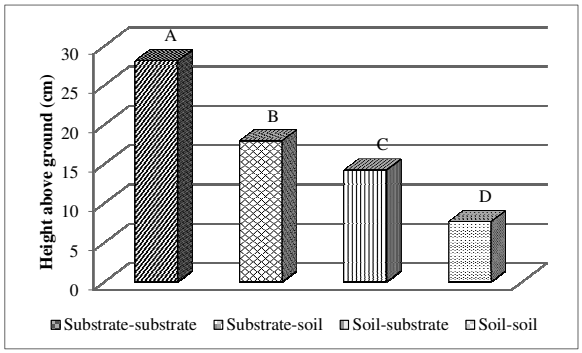

Fig. 2. Above ground plant height Tagetes patula nana leafes in different growth variants

Number of side branches depended of growth medium (Table 1) and it was from 5.52 and 13.4 (Figure 3). There was a significant difference ($LSD_{0.01}$ 1.3024) in number of side branches. In plants growth in variant substrate-substrate the highest number of side branches has been determined (13.4). In variant soil-substrate for ornamental flowers, that number was 9.4 and in

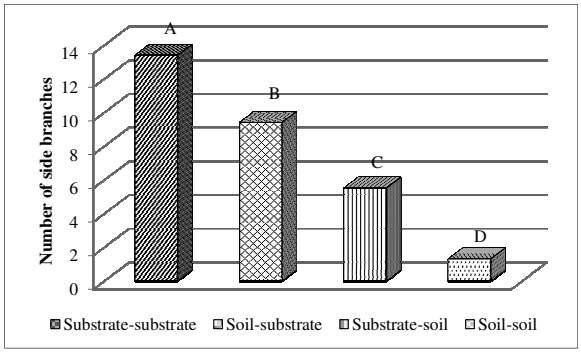

Fig. 3. Number of side branches Tagetes patula nana in different growth variants

variant substrate for transplants-soil, it was 5.52. The smallest number of side branches was in variant soil-soil (1.31) (Figure 3).

The growth medium has significant influence (Table 1) on the mass above ground of Tagetes patula nana ($LSD_{0.01}$ 1.6799). Measured values of Marigold plants mass above ground were in range between 5.01 g i 47.85 g (Figure 4).

The highest mass above ground had plants growth in variant substrate-substrate (47.85 g). Lesser mass above ground (37.74 g) had plants in variant soil-substrate for ornamental flowers. In growth variant substrate for transplants-soil determined mass above ground was (16.88 g.). The smallest mass above graound had plants in growth variant soil-soil (5.01 g) (Figure 4).

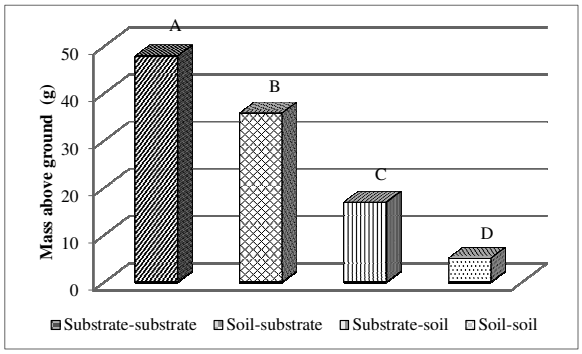

Fig. 4. Number of side branches Tagetes patula nana in different growth variants

Number of buds and flowers Marigold (Tagetes patula nana) was under signifficant influence og growth medium (Table 1), and it was between 0.98 i 5.06 (Figure 5). The diffrerences ($LSD_{0.01}$ 1.6655) in number of buds and flowers of Marigold growth in variant substrate-substrate (5.06) and all of the others has been determined. Between plants growth in variant soil-substrate for ornamental flowers (3.08) and in variant substrate for transplants-soil (2.02) no significant difference in number of buds and flowers has been determined. Also, between variants substrate for transplants-soil (0.98) and variant soil-soil no signifficant difference has been determined (Figure 5).

Among plants Tagetes patula nana growth in different variants (Table 1) the significant influence of growth medium has been

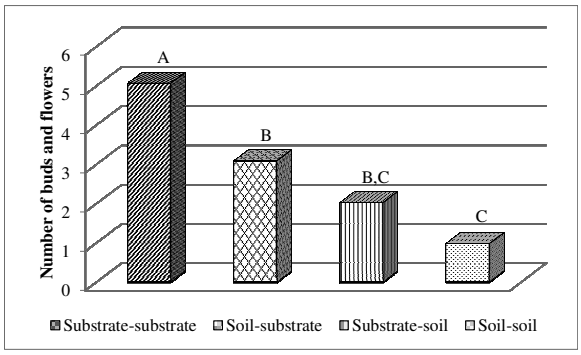

Fig. 5. Number of buds and flowers Tagetes patula nana in different growth variants

established depending diameter of flower and it was in a range from 0.23 cm to 1.47 cm (Figure 6). Significant difference ($LSD_{0.01}$ 0.8605) in diameter of flower was determined between variants soil-substrate for ornamental flowers (1.47 cm) and soil-soil (0.23 cm) as well as between variants substrate-substrate (1.42) and soil-soil while in variants soil-substrate for ornamental flowers and substrate for transplants-soil (0.76) and substrate-substrate and soil-soil were no significant difference (Figure 6).

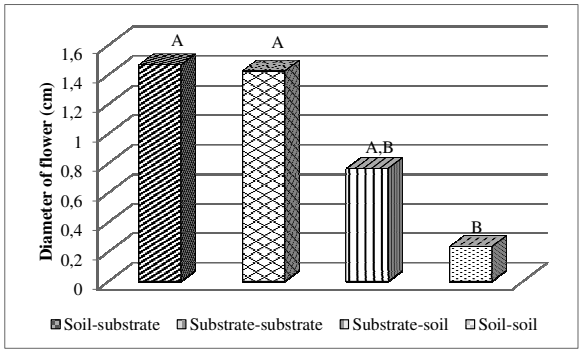

Fig. 6. Diameter of flower Tagetes patula nana in different growth variants

The cultivation of the Marigold is popular among the proffesional flower and ornamental plants breeders in Croatia because of the easiness in cultivation, long duration of flowering as well as due to the wide addaptability of Marigold to varying soil and climate conditions.

Although, the results of many investigations as welll as in present experiment, indicates that growth medium has signifficant influence on Marigold quality. Best quality Marigold seedlings were produced when peat is the principal component of the growing media

[23,7]. In these experiment transplants grown in substrate for transplants developed 4 leaves within 24 days and those in soil developed 4 leaves within 37 days. In experiment Maslanka et al. (2017) the tested Marigold substrates (with peat) where characterized by much better growth (increased by height) and significantly better flowering in comparison with the other substrates used [4]. Using soil and mix media as growing medium for Tagetes erecta L., Sharafzadeh et al. (2013) were geting enhanced plant height and leaf number in mix media (1/3 soil, 1/3 sand, 1/3 peat) [2]. Higher plant height, number of flowers and flower size has been achieved when growing Marigold in mixing media (compost, bio-organic fertilizer and rice husk charcoal) in comparison with those grown in soil [3].

Beside plant, height and leaf number in this experiment a positive influence of substrate, which comprises peat, was determined on mass above ground and number of side branches. Although, the decreasing of values that was statistically significant was determined on plants grown in soil. Within values of measured parameters (plant height, leaf number, mass above ground and number of side branches), the regularity of decreasing can be observed regarding variety of growing: substrate-substrate, soil-substrate, substrate-soil and soil-soil.

Although in this experiment, the influence of growing media has been proven regarding number of buds and flowers and diameter of flower. There was no evidence of significant difference between different variety of growing Ekwu et al. (2007) have not determined significant difference regarding number of flowers and diameter of flowers growing Marigold in mixture topsoil and river sand or ricehull and riversand [17]. Sharafzadeh et al. (2013) found no significant difference in flower diameter of marigold growing in soil and mix media (1/3 soil, 1/3 sand, 1/3 peat), but they determined more blooms in those growth in soil [2].

Materials suitable for amending soil for container plants must provide good drainage and aeration must be low in soluble salts, it must be light in weight, capable of retaining moisture and nutrients and releasing them as the need arises [17]. According Strojny et al. (2004) mixture of medium structured white peat and black peat (very low bulk density, very high porosity, easy available water and air-filed pore space) enables most intensive growth Marigold [24]. The substrates used in this experiment meet the above conditions because they have been produced for ornamental flowers growing. However, soil used in this experiment, which is widely prevailing in a Brod-Posavina County have no required chemical and more important physical characteristics (due to high clay content) needed for uninterrupted development of Marigold plants although they are known as not demanding for growing.

4. CONCLUSIONS

The influence of growing media on morphological properties of Tagetes patula nana has been determined in all growing stages. The transplants growth in substrate were developed faster than those in soil. The difference in plant height, leaf number, mass above ground and number of side branches was depending of growing variant ($P \leq 0.01$). Values of measured parameters were running from highest to lowest as followed: substrate-substrate, soil-substrate, substrate-soil and soil-soil. The highest number of buds and flowers was determined in variety substrate-substrate and the lowest in soil-soil ($P \leq 0.01$). The smallest difference among varieties was determined for flower diameter. In the average, all plants morphological characteristics, were limited by the soil properties.

5. ANNOTATION

In this part author can thank to people and institutions co-operating in the research or mention the name of the grant or project name and the name of the funding agency.

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Analysis of Possible Tribological Losses during Stemming of Tobacco

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Abstract

Primary stage of Burley type tobacco in thresher machines includes separation of fine parts of tobacco leaves from the ribs, the so called "stemming". Thereby cutting edges of knives are exposed to wear by abrasive particles. Analysis has been performed of the influence of two kinds of protective layers on thresher knives on quality of stemming, depending upon tobacco leaves blend. It has been established that operation with worn knives is most negatively reflected on the most quality tobacco fractions – those having the greatest market value. It has been proved that application of sprayed layer instead of installation of plates made of hard metal, followed by partial exchange of worn knives can tribological losses even up to 6 %.

Keywords: tribological losses, efficiency, stemming of tobacco, knives

1. INTRODUCTION

After harvesting and natural drying to 15÷17% of moisture content, tobacco is classified into grades. The best quality is the leaves from the middle of the stem, and less quality the ones from the upper and bottom part. Lower leaves are necessary to dusted - clean from soil and sand particles. Dusted and classified (by size) tobacco leaves are conditioned (with water, water vapor and with hot air temperature about 150 ^{o}C) and they come across the dispenser to the stemming line. On the threshers in several stages by picking is made the stemming/separation of the fine part of leaves from the ribs. Dimension of threshers in I. and II. stage are 42", in III. and IV. 30".

So partially stemmed tobacco leaves are drawn to classifiers where the slice fraction (by size) is separated into 7 stages. Unstemmed parts after each of stages are taken to the again threshing (III. stage). The size of these threshers is 36". From stemmed tobacco, by the system of sieve ø5 mm separates the hay, and then separates it from tobacco dust. Tiny residue is mixed with the previously separated slice (subsequently dried in the so-called redryer). In the next phases, the separated fractions are dried, conditioned and pressed and packed, after which they are ready for dispatch on the further final processing in a smoking form. Also, after extra drying by the sieve system is separated large from the small ribs, and even after the packing is ready to be delivered for finishing to separate the parts suitable for use in preparing the cigarette.

In the mentioned stages of primary treatment of tobacco wear are the most exposed knives of thresher on which the main stage of processing is perfomed – stemming of tobacco. The aim of test is to determine whether and how much wear of the knives affects on the quality of stemming,

which should help in choosing of the knives protection procedure.

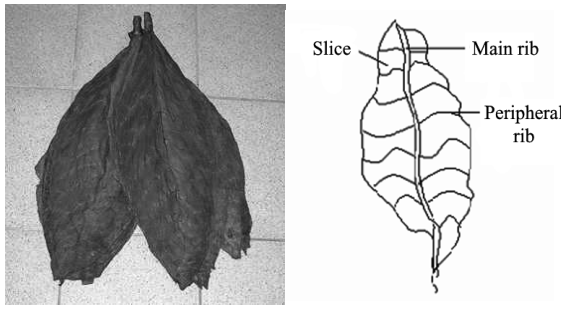
2. TRIBOSYSTEM OF THRESHER

Figure 1 shows an open thresher with an arrangement of working parts in the open housing. On each side in the row are fixed 17 fixed knives. These knives during their work do not change their position, they are fixed from each side of the thresher stator to the side doors. They are placed perpendicular to the axis of the rotating drum at angle 180°. The rotating knives are fixed on the circumference drum in the 6 rows. Each row contains 16 knives, and the rows are rotated with each other for angle of 60°, and the thresher drum contains a total of 96 rotating knives.

Fig. 1. The appearance of open thresher

The composition of tobacco leaves depends on the position of leaves on stem, fertilization, and on the type of soil on which the plant is grown. The following types of soil are characteristic for the central and eastern part of Slavonia: clay, slightly humus and less sandy. In unstemmed tobacco is characterized by the following percentages [1]: nicotine (0,78 ÷ 4,59); cellulose (7,36 ÷ 15,76); starch ≈ 3,34; citric acid ≈ 6,3; malic acid ≈ 3,2; ammonia ≈ 0,55; resin ≈ 5,6; waxes ≈ 0,2; pectins ≈ 17 and total nitrogen ≈ 2,2. On the stem of tobacco, especially the lower leaves are exposed to deposition and sticking of the soil particles (due to rain and wind). The aim is to remove dust and sand.

Tobacco is a plant that abounds in minerals that can be in the form of oxides, carbon or mineral salts [2]. The elements which involved in the composition of the minerals were determined by analysis of ash composition after tobacco combustion. The orientation ash composition of the tobacco leaves is as follows: potassium 19 ÷ 29 %; calcium 27 ÷ 50 %; magnesium 7 ÷ 15 %, phosphoric acid 2 ÷ 5 %, silicon 5 ÷ 18 % and chlorine 0,55 ÷ 9 %. Figure 2 shows a characteristic tobacco leaves. Along the central part of the leave is located the main rib. Around him the peripheral ribs are located. The upper surface of the leaves is covered with thick hairs which produce tires and juices (oil tar). This oil tar during the harvest in the form of black rubbery clusters accumulations is sticking for hands and machines and can be sticking to the knives when stemming in threshers.



a) *b)*

Fig. 2. The characteristic appearance of tobacco leaves: a) dry leaves and b) schematic view of the position of slice and ribs

The main and peripheral ribs, due to their armature roles, contain stronger connective tissue which after drying and moisture loss becomes woody. When filling a thresher, the leaves of tobacco in the work area fall across the entire surface between the fixed and rotating knives, providing maximum resistance to the machine when picking.

3. CONDITION ASSESMENT

It was noted that knives are made with one of the following two types of protective layers [3]:

- hard metal tile;
- sprayed layer.

Schematic appearance of individual knives with a protective layer is shown in Figure 3. The characteristic appearance of knives after wear is shown in Figure 4.

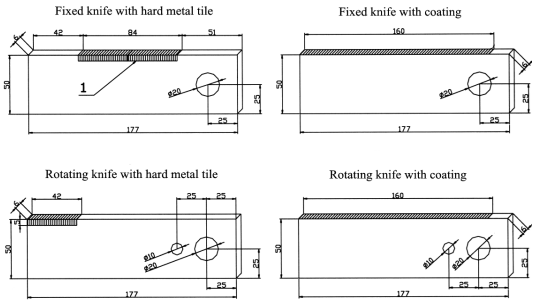
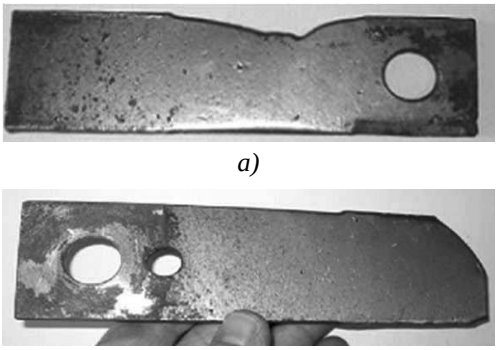


Fig. 3. Schematic view of fixed and rotating knife



a)

b)

Fig. 4. The characteristic appearance of knives thresher worn by use: a) fixed knife and b) rotating knife

It was found that knives with hard metal tile are more prone to sticking of oil tar than knives with sprayed layer. As the procedure of removing these clusters is perfomed by hits with a metal cutter, it often happens to crack the hard metal tile [4].

4. TEST RESULTS

In order to determine how much wear of the thresher knives affects on the quality of stemming, tests have been performed on the share of individual fractions (size of the stem) after the treatment of tobacco with new and worn knives. The control of stemming was performed in the laboratory by standard method on the prescribed equipment. By standard of the vibration sieves they are separated by three slice size (fractions): first: 1"x1"; second: 1/2"x1/2" and third: 1/4"x1/4".

At this time, the largest fraction is at the same time the highest quality and the one on the market achieves the highest price. The share of fractions was monitored on each of the three possible mixtures (position of leaves from the stem). The reason: this significantly affects on the price. Tables show the results of the share of individual fractions for each mixture:

- work with new knives, and
- work with partially damaged knives.

Table 1 shows the percentage ratio of the share of fractions of the slice size 1/2" + 1" in the control mass of 12 samples of the tobacco mixture during a single campaign. It is noted that the differences in the share of these fractions when working with new knives compared to worn work ranges from 0 to 4,5 %. The same is true for the tobacco rib.

Table 1. The share of fractions for 1/2" + 1/4" of slice size when stemming a mixture of tobacco when using new and worn knives.

Number of sample	Share of fractions, %	
	New knife	Worn knife
1	87,8	83,0
2	83,8	80,9
3	90,5	82,2
4	88,8	83,5
5	87,1	83,0
6	92,7	85,7
7	87,9	87,4
8	86,9	86,5
9	91,3	88,3
10	87,8	85,5
11	89,6	87,7
12	88,6	86,3

By observing the share of the smaller fractions (1/2" + 1/4" + 1") of the mixture has been determined that it does not depend on the intensity of the wear of knives. It should be noted that these smaller fractions on the market achieve a lower price. Table 2 shows the share of fractions after stemming the mixture of upper and middle leaves. It is noted that almost the same results are obtained by stemming with new and worn knives.

This is true for share of fractions 1/2" + 1" as well as for fractions 1/2" + 1/4" + 1", as well as for the tobacco rib.

Table 2. The share of fractions for 1/2" + 1" of slice size when stemming a mixture of upper and middle leaves depending on the wear of knives.

Number of sample	Share of fractions, %	
	New knife	Worn knife
1	98,63	97,84
2	97,81	98,60
3	96,63	98,22
4	98,47	97,33
5	97,46	98,52
6	97,53	97,70
7	97,90	97,73
8	98,68	98,08
9	98,58	97,13
10	97,35	96,88
11	97,33	97,98
12	97,82	97,93

Table 3 shows the share of fraction after stemming the mixture of the middle and lower leaves. It is noticed that share of fractions 1/2" + 1" when working with new knives is up to 6 % higher than when working with worn knives. At the same time it was noted that at these smaller fractions (1/2" + 1/4" + 1") of this mixture, as well as in the tobacco rib, these differences reach up to 1,5 %.

Table 3. The share of fractions for 1/2" + 1" of slice size when stemming a mixture of middle and lower leaves when using new and worn knives.

Number of sample	Share of fractions, %	
	New knife	Worn knife
1	87,92	83,59
2	88,44	87,20
3	87,02	83,65
4	86,10	83,08
5	85,37	82,19
6	88,69	82,44
7	88,43	84,49
8	87,79	83,71
9	89,50	85,17

5. ANALYSIS OF RESULTS AND CONCLUSION

Due to the aggressive anti-smoking campaign, the tobacco industry is in a specific position. And therefore the possibility to present research results in this area. The results of test for the share of high quality fractions (1/2" + 1") and the fractions of lower price (1/2" + 1/4" + 1") for the three basic groups of tobacco leaves mixtures indicate the following:

- for a mixture of tobacco difference in share of quality fractions (1/2" + 1") when working with new knives it is up to 4,5 % compared to work with worn knives,
- for the mixture of upper and middle leaves, the effect of knives wear on the share of the individual fractions is not observed,
- for the mixture of middle and lower leaves mixes the difference in the fraction of quality fractions (1/2" + 1") when working with new knives it is up to 6,25 % compared to work with worn knives.

According to available data [5], tobacco production in Croatia is about 12,000 tons per year. To estimate possible savings, it is sufficient to say that, depending on market relationships (defined every year at the beginning of the purchase and primary processing of tobacco), each percentage of worse stemming reduces the fraction price for at least 2, most often 3, and in some years up to 4 %.

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APPLICATION OF MACHINE LEARNING IN THE COLOR SORTING OF AGRICULTURAL PRODUCTS

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Abstract

Machine learning is a learning field that gives computers the ability to learn without explicitly programming them. The two main components of machine learning are data and algorithms. Algorithms process data, train (train) parameters, and in this way acquire the ability to make decision-making decisions by adapting new data. Machine learning is widespread in various fields both in agriculture and in the food industry, either in terms of fruits, vegetables, finished products, cereals or meat industry. It takes a special application in machine vision, which allows machines to learn from experience, adapt to new technologies and perform human tasks. Mechanical vision provides an alternative as an automated, non-destructive and cost-effective technique for achieving demands and expectations in terms of health food safety prescribed by international standards.

The industry will also have a great role to play, including full digitalization and automation of production, or the networking of smart digital devices with products, machines, tools, robots and people. It is imperative to create "smart factories" where autonomous cyber-physical systems monitor physical processes and make decisions, and the ultimate goal is to increase productivity and efficiency, and therefore competitiveness in the global market.

Deep Learning is an encouraging concept of artificial intelligence due to its ability to extract features from images and high precision in the field of digital image processing and thus the agricultural and food industry in the field of quality control.

Keywords: machine learning, inspection, quality, agriculture

1. INTRODUCTION

Everything that was created by technology up to now actually represents a product of intelligence. For many years, artificial intelligence has been intensively developed and applied in both various industrial fields and medicine. Machine learning represents the combination of *Data science* and artificial intelligence. Challenges and problems solved by machine learning can be difficult, however, by developing complete software solutions, they are much easier to solve, through various approaches and algorithms.

Initial research and the term itself date from the fifties era of the twentieth century. The development of a system for automatic recognition of hand-written numbers which uses neural networks were considered as demanding engineering problems. Nowadays, these systems are designed in very quick manner, and are typically used as illustrative basic examples, similar to writing code for writing of the words “Hello world” on-screen. Machine learning algorithms are used for: classification, segmentation, regression and recommendation systems. Machine learning can be used for the purpose of automating of repetitive tasks.

Extensive research on the subject had shown that it has considerable potential for inspection and evaluation of fruit [1], vegetables, grain and legumes quality [2], bruise and disease detection [3,4], as well as for evaluation of other various food [5-8], meat products [9-11], and combined with machine sight [12-14]. In addition to its wide application in agricultural product processing, machine learning algorithms are successfully applied in combining of menus and recipes, diet recommendations [15,16], customer behaviour predictions, etc.

The readiness of the consumer to purchase a product mostly depends on its organoleptic properties, which typically include colour, which represents a subjective feeling of each consumer. Colour can also be considered as an indicator of freshness or maturity [17], wherein a combination of machine sight and learning can show its full potential during the inspection, sorting and classification of agricultural goods.

Different physical systems were developed for the purpose of avoiding subjectivity during colour analysis that can be performed visually, or by using specific instruments. Conventional instruments only analyse a small part of the sample, hence they are not always adequate for products with a heterogeneous surface. As a consequence, artificial visual systems were developed recently in order to overcome these issues, making the colour analysis more accurate and comprehensive, including the entire surface of a product during its processing [18]. In this sense, non-destructive technologies for agricultural product quality assessment, such as machine sight, represent a quality control tool, used for evaluating, sorting and selection.

2. BASICS OF MACHINE LEARNING

Machine learning algorithms do not require long codes to be written, mainly due to vectorisation, which allows the processing of arrays in a much faster way, without the need to use loops.

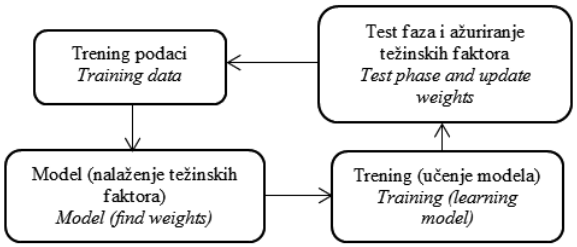

Figure 1. Life cycle of machine learning

The initial step involves the creation of a model and the testing process (the so-called *training model*). This includes the defining of the desired output format, in terms of whether it is a discrete value (1 or 0, yes or no, true or false, option 1 or option 2), the value range, categories, classes, etc, as well as gathering of a certain number of data which will be used for learning, validation and tests. All of the above influences the type of learning which will be applied.

In general, it is necessary to gather or develop a certain number of training data which will contain a set of attributes and probable outcomes.

The goal of this training is to create a model which will provide accurate answers to the given questions in most cases. In order to successfully train the model, it is necessary to gather the input data which contain a large number of variations. Further, it is necessary to select the features which best describe the model, based on which the algorithm will provide an accurate output. When it comes to agricultural products, it is mostly the physical properties which are evaluated, such as geometric features [19], colour values in various colour ranges [20], as well as statistical values of these parameters [21].

How good a predictive model is depends on the quality and quantity of input data. This process is called *exploratory data analysis*, *EDA*, and it aims to review the data in visual and non-visual manner to familiarise itself with and recognise the samples and patterns which appear in the data, in order to finally decide how to use this data in further analysis. In addition, it is required that the data belong to a similar or the same scale, thus in the case that the 'raw' data do not, it is necessary to scale or normalise the data, mainly for the purpose of reducing data processing times using the selected algorithm. Data scaling is typically performed over an interval of -1 to 1:

$$x = \frac{n}{n_i \max} \tag{1}$$

and the following two equations can be used for normalisation:

$$x = \frac{n_i - \mu_i}{\max n_i - \min n_i} \quad or \quad x = \frac{n_i - \mu_i}{S_i} \tag{2}$$

It is necessary to have 2 sets of data: the training set and the test set. In certain cases, a third set are also taken into account (the validation set or the development set), which is used before the comparison set for multiple algorithms and/or regularisation methods. Gathered data for training algorithms can be divided into sets according to the following groups: 70% training set – 30 test set, although values of 65% - 35% and 80% - 20% are sometimes taken into account. When using the validation set, the division is as follows: 60% - 20% - 20%. Recently, during the so-called *Big Data era,* wherein the amounts of data exceeds several millions, the use of validation tests, if necessary, requires a lower percentage, 1-2% of data, in order to decide which algorithm structure gives the best results. Same applies to the test set. One of the requirements is that both the validation and test set originate from the same data source.

The main goal is to find a hypothesis function $y=h(x)$, which corresponds to every example in the training set $y_i=h(x_i)$, where y represents the output and x represents the input value of a feature. The simplest model in this case is the linear regression. The hypothesis function can be written as $h_\Theta = \sum \Theta_j x_j$, or in vector form: $h_\Theta = \Theta^T X$. It is necessary to find the appropriate $\boldsymbol{\Theta}$ which minimises the ***cost*** function. The most commonly used algorithm for this problem is the ***gradient descent***, which simultaneously updates the weight factors, until the convergence is achieved [22].

$$J(\Theta) = \frac{1}{2} \sum_I \left(h_\theta \left(x^{(i)} \right) - y^{(i)} \right)^2 \tag{3}$$

Due to a large number of data, especially when it comes to colour images, some researchers first reduced the number of input data by using specific statistical techniques, one of which is the widely used Principal Component Analysis, PCA [23-25].

Data processing time represents one of the key factors in applying of real time sorting of agricultural products with industrial capacities within the order of magnitude between 1 and as much as 50 t/h. Due to significant amounts of data per unit time, it is recommended, but also necessary, to develop an efficient algorithm which requires shorter data processing times.

For the purpose of evaluating the success–fulness of a developed model, the measure F is used, which is calculated as follows:

$$F = 2 * R * P / (P + R) \tag{4}$$

which provides insight into the accuracy of the algorithm [11].

P - (Precision) is the measure which shows the ratio between correctly classified objects within a certain class and the objects classified as that class, and is determines according to the following formula:

$$P = TP / (TP + FP) \tag{5}$$

R - (recall) is the ratio of correctly classified objects and the total amount of objects in that class.

$$R = TP / (TP + PN) \tag{6}$$

TP – (True positive) represents the positively identified, FP (False positive) – the incorrectly positive and FN (False negative) – incorrectly negative.

3. MACHINE LEARNING TIME AND APPLICATION IN AGRICULTURAL INDUSTRY

Two basic types of machine learning are the supervised learning and the unsupervised learning. Supervised learning algorithms have a wider applications, wherein the inputs, $x_1, x_2, \ldots x_n$, are those that best define the model or an object, and where the outputs $y_1, y_2, \ldots y_n$. are known for input characteristics and the relationship between them is also known. They can be divided into two learning categories: regression and classification. Algorithms which are most commonly used include: linear

regression, multivariate regression, logical regression, neural networks [26,27], support vector machines – SVM [28] and many others. Classification is most commonly encountered when using machine sight during agricultural product inspection, wherein the separation of non-conforming products from the conforming ones takes place, and represents the final step of this segment of the industrial line. In addition, it is common practice to sort agricultural products by class (degree of ripeness, size…) or according to sorts where machine learning algorithms have shown impressive results. Artificial intelligence algorithm application to inspection and quality assessment of agricultural products is a broad and inexhaustible subject for many researchers in the field of agricultural and food industry [29,30].

The authors of paper [31] have compared three algorithms: SVM, neural networks with two hidden layers and the Random forest algorithm, in the case of pictures of bananas, in clusters, rather than individual pieces. Features that were considered included the colours in the RGB colour spectrum (red, green, blue) and the banana length, measured from the beginning of the cluster. The aim was to sort the bananas into four classes. All three models provided highly satisfying results, with the classification accuracy F up to 87-90%, wherein the Random forest algorithm gave the highest accuracy rating of over 94%. It was determined that higher values of RGB parameters and measured lengths corresponded to a higher class. The banana length parameter had a bigger part in the classification process, since in certain cases there was an overlap in number values.

Machine learning also represents an attractive approach to detecting of fruit in the boughs. In paper [32], SVM was used to recognise objects in the orchard during the picking. Parameters that were used included the texture of the products from the specific interest regions. Tests have shown an accuracy of more than 86%, even in the case of products which did not fully mature, under different lighting conditions. Thus, the results were satisfactory in terms of real time needs and conditions, compared to the four previously proposed methods which did not include machine learning.

SVM algorithm was used for detecting of apples in boughs, through the use of two sets of data for two different years, wherein the algorithm that was trained in the first year provided satisfying results for the next year as well, under different lighting conditions [33].

A combination of machine sight and neural network for the purpose of classifying fowl parts in real time was described in paper [11]. For each of the 5 specified classes, 100 samples were prepared and recording was performed using an integrated machine sorting system. Features that were used in the neural network include product shape, colour parameters in RGB and HSV spectrums and product texture, described using entropy, energy, contrast and homogeneity. The machine capacity was around 0.85 t/h, which corresponds to the industrial capacity of the meat industry. The result at maximm transporter spped of 0.2 m/s was 94%. It was agreed upon by the authors that deep neural networks would have achieved a significantly better results in this particular case.

Unsupervised learning represents an approach to problem learning related to situations where the learning algorithm is only presented with data that have no output, and is expected to observe certain laws in the provided data on its own. It can derive the results by, e.g., classing of data based on the relationship between the variables in a data set – also known as Clustering. In the case of unsupervised learning, there are no recalls based on prediction results.

4. DEEP LEARNING

The last developed branch of machine learning is the *Deep Learning*. It is used to describe a set of algorithms based on the neural network concept. In general, these algorithms attempt to imitate the neuron functionality, which enables them to efficiently learn by example and then apply what they have learned to the new data. A recent increase of interest in deep learning has largely resulted from the

availability of powerful graphic processing units, which can train and perform deep learning algorithm in an efficient manner. This allowed the scientific community to enhance the research and application within this field, leading the algorithms to a point in which their performances surpass the majority of traditional machine learning algorithms in several categories.

Their widest application is in the field of machine sight, wherein a single 150x150 pixel image (and these resolutions are typically much higher) can be transformed into 22500 neurons in the input layer, which represents a considerable issue for classic neural networks. Colour images represented in various colour spectrums usually have 3 channels (RGB, Lab, HSL…), giving 67500 neurons to a layer. Such problems are usually solved using convolution neural networks – CNN. The best known models are the AlexNet [34], VGG16 [35] and Inception-ResNet [36]. The idea of CNN is to place a larger number of layers for detecting of important features of input data. In accordance with this idea, convolution filters are applied to the image in order to determine and map the useful features.

The middle component in achieving and maintaining of high performance of applications based on deep learning is the possibility of continued model updating, simultaneously with gathering larger amounts of data, which enables increased model accuracy. All of the deep learning characteristics mentioned above are applicable to and necessary for enhancing the performances in areas where machine sight is used. As the application of deep learning represents a relatively young field, its use in agriculture is best described in the literature review paper [37].

5. CONCLUSIONS

There is a significant need for machine learning in the global market. The development of this areas had always been based on complementary relating of theory and experiments, hence future development also requires the extension and strengthening of theoretical knowledge, above all in a mathematical sense, but also of knowledge about specific fields of application, along with their adequate formalisation.

The results of machine learning algorithm application to evaluation and inspection of agricultural products provided impressive outcomes, since they can significantly reduce the data processing time, as well as the percentage of good agricultural product loss. Once the model is created and trained using one of the artificial intelligence methods, it can then be used independently for predicting (detection) of conforming products and the contaminity, by using new input variable values. Such a model can be used by engineers or employees with different levels of knowledge, without the need to know how simulations software works. In time, models can be additionally expanded and trained using a larger number of variable, which would make their application more comprehensive. By applying these models, the subjective influence of the operator behind the machine, who decides on the range of parameter values for features that define the appropriate product, decreases with time.

The development of efficient software packages for non-destructive inspection of agricultural products represents and imperative in creating of new technologies in the agricultural and food industry branches.

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Structure of Farmers Education and Knowledge about Importance of Melioration Interventions

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Abstract

The questionnaire survey about education, years of age and willingness to invest in constant and the stabile yield through melioration interventions of Slavonian farmers was carried out in year 2016/2017. in the County of Brod-Posavina. Sample of questionnaire consisted a total of 255 respondents from this Slavonian county. The aim of the paper was to provide a kind of link between education, years of age, melioration systems and possible yield increase through twenty-four questions. The questionnaire found that the majority of respondents have a high school education, agriculture is not their primary activity, and their age is generally from 45 to 60 years of age. According to the conducted questionnaire, 65% of agricultural producers have a problem of lack of water during the vegetation period. Farmers awareness of the importance of melioration interventions does exists, but 77% of them are not ready to invest in irrigation or drainage.

Keywords: agriculture, melioration, education, investment

1. INTRODUCTION

All branches of agricultural production are very important in the food production chain for nearly ten billion people on planet earth. During the last two decades we have met unstable climatic conditions which effect on the quality of life through the lack of drinking water and the destruction of agricultural soil. To insure constant and stable yield during intense rain seasons or irrigation during long-lasting dry periods we can affect by applying melioration measures. In the Republic of Croatia there is a whole range of regulations, measures and plans in the area of water protection. There is a total of 2 695 037 ha of agricultural soil, but only 1 100 000 ha are cultivated [1]. Under the underground drainage and other drainage systems in Croatia there are 134,000 to 166,000 ha of agricultural soil [2]. Easily available and plant accessible water has a very important role in securing and increasing yields. At the same time, the price of water used for irrigation has a significant impact on production costs. Income from the agricultural economy due the water price used for irrigation and construction of the melioration system can reduce revenues by 25% to 40%. It can significantly effect on farmers quality of life. [3], [4]. Research the effect of irrigation on yield of oilseed rape (*Brassica napus*), shows that all investigated irrigation systems increase the number of plants per plant and the mass of 1000 grains [3], [4]. The results of researches of different irrigation systems (underground irrigation, irrigation Drop by Drop, furrow irrigation) on the yield and quality of sugar beet shows that highest yield was on Drop by Drop irrigation method, and the highest concentration of sugar was on furrow irrigation method [5]. Studying of irrigation and water prices on profits in the Mediterranean Spanish regions show that the price of water significantly effect on the price of produced fruit. By that fact

farmers are encouraged to produce more profitable fruits with lower requirements for water and state is supporting them to carry out the sustainable water system in agriculture - Water Directive (WFD) [6]. Irrigation can be recommended as an effective measure of constant yield or even measure for increase corn yield in this highly variable climatic conditions (confirmed with monitoring of soil moisture content by electrical resistance measurement) [7]. Melioration measures are a widely researched, valuable and sustainable strategy for the development of agricultural production especially in regions with variable climatic conditions. The primary aim of irrigation is to provide enough water in all phases of plant development which leads to maximizing of water productivity and stable yields, but not to maximum yields [8]. The aim of this paper was through twenty-four questions asked in the questionnaire to get a link between education and year of age of Slavonian farmers and their willingness for investments in melioration interventions to insure constant and stable yield.

2. METHODS AND MATERIALS USED FOR RESEARCH

The questionnaire about education and year of age of Slavonian farmers and their willingness to invest in melioration systems was carried out in 2016/2017. at the Brodsko-Posavska County as part of the Slavonia region in the Republic of Croatia. The sample consisted 255 respondents employed in agriculture as a primary activity or in other activities with agriculture as a supplementary activity. Questions in the questionnaire survey was about the level of education, years of age, primary and supplement activity of the respondents, melioration systems, investment willingness and farmers knowledge of possible yield increase.

3. RESULTS AND ACHIEVEMENTS

Questionnaire survey show that 29% of respondents are employed in agriculture as their primary activity, but for 71% of respondent agriculture is their supplementary activity. Total questionnaire survey took place on 255 family agricultural estates. Results of agriculture branch activity show that 28% of are covered with agriculture crops, 18% with vegetables and flowers, 8% with fruit, 6% with wine yards and cattle breeding is present with 4%. Most of family agricultural estates simultaneously dealing with more branches of agriculture production (35% of them).

3.1. Economic and social structure

Questionnaire survey about size of agricultural production areas show next: size of 1-3 ha are represented by 25%, size of 3-10 ha are represented by 22%, area of less than 1 ha is significantly represented at 21%, soil surfaces of 10-50 ha occupy 14%, areas 50-200 ha are represented by 15%, and the least represented area are those greater than 200 ha represented with 3%. Figure 1. presents respondents education level, while Figure 2. presents years of age of the respondents in Brod-Posavina County.

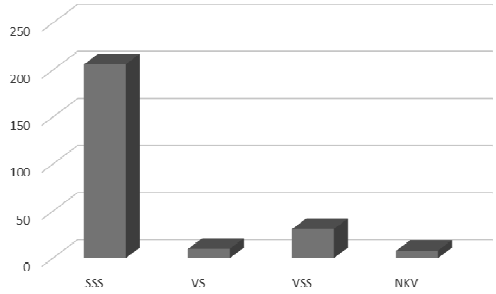

Fig. 1. Education of the respondents

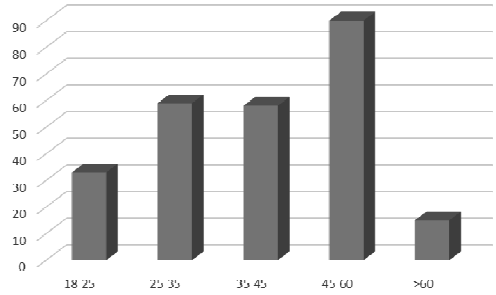

Fig. 2. Years of age of respondents

Most respondents have high school (81%), then 2nd or 3rd Bologna cycle (VSS) has 12% of respondents, while the least number of respondents has 1st Bologna cycle (VS) of 4%

and elementary school (NKV) 3% as level of education. Year of age questionnaire survey research shows that 45 to 60 years of age has 35% of respondents who are mostly employed in agriculture and 6% of respondents are older than 60 years of age. Respondents between 25-35 years of age and 35-45 years of age are represented with similar 23%, and respondents with 18-25 years of age are represented with 13% of all respondents.

3.2. Recognition of water problems during the vegetation period

Problem with overmuch of rainwater or underground water has 56% of respondents, while 44% of respondents doesn't have that problem in their agricultural production soil. The problem with the lack of water during the vegetation period has 65% of respondents, and 35% of the respondents does not. Most farmers do not plan to invest anything (Figure 3.) in any of melioration measures (77% of them), while 31% of farmers are planning to invest 10-30% of their net profits in some of melioration systems. Significant investments of 30-60% of net profit will invest 1.5% of respondents while more than 60% of net profit will or planning to invest only 0.5% of respondents.

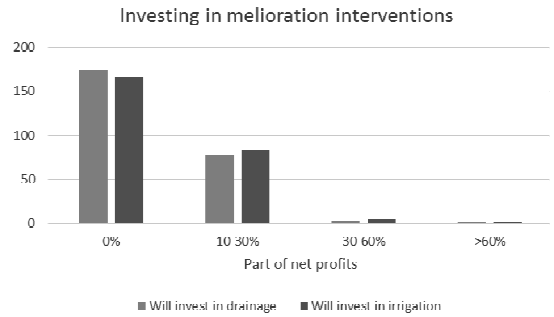

Fig. 3. Part of profit reserved for melioration

3.3. The benefits of irrigation systems and co-financing

Agricultural producers from this questionnaire are familiar with the benefits of irrigation and possible yields increase. In case of using some of the irrigation method 127 respondents would expect yield increase of 10-30%, similar number of respondents (50 and 59 of them) expect yield increase of less 10% and 30-60% increase, while only 18 respondents expect increase of yield more than 60%. Future investment in melioration systems through tenders in EU financing funds is planned by 15% of respondent farmers, while 85% of respondent farmers are not planning to compete on tenders. The main reasons for not compete on tenders are: complicated paperwork, project cost, and own estimation that they are without a chance to win a project.

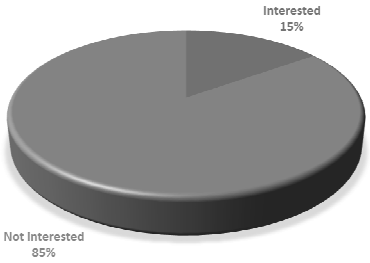

Fig. 4. Interest in compete in EU finance fund tenders

4. CONCLUSIONS

Questionnaire involved total of 255 family agricultural farms. Surveys results show that 29% of respondents are employed in agriculture as a primary activity, while 71% of respondents are employed in other activities with agriculture is a supplement activity. Most of farmer respondent (35%) are 45 to 60 years of age, while 18 to 25 years of age respondents are present with only 13%. At the same time 81% of respondents has high school education (SSS). Sufficient number of respondents has higher education level, 2nd or 3rd Bologna cycle (VSS) has 12% and 1st Bologna cycle (VS) has 4%. All agricultural producers from this questionnaire are familiar with the advantages of melioration systems that provide constant or even higher yields. Survey shows remarkable high level of unwillingness of the respondents (77%) to invest part of the profit in some kind of melioration systems. Most of respondents (85%) are also not interested in financing a melioration system through EU financial fund tenders. The need for water and sustainable water management leads to the farmers need to expand their professional knowledge in building and improving of melioration systems.

5. ACKNOWLEDGEMENTS

Special thanks to the students of the 2nd year of Horticulture course at College of applied sciences in Slavonski Brod who assisted in the implementation of this questionnaire survey as part of the Agricultural melioration module.

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MANAGEMENT

Impact of Technological Innovation on Enterprise

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Abstract

In the business world only innovations-based enterprises, something new or new-fashioned, achieve success and thus increase the satisfaction of all involved in economy process. The local, regional and especially global success of a company depends on the ability to innovate and introduce innovations into production processes where the main source of competitive advantage is creativity. Creativity is the ability to create and develop new products and services, their introduction into everyday business and life of an enterprise; as an improvement of the production process, the creation of a new product or a new way to market. Unfortunately, in Croatia, creativity and innovation are not on the scale of prophecy, which is why Croatia is far behind the developed world even though is recognized as a highly creative in history because it is commonly known that in the past Croatian inventors and innovators with their inventions. Croatian innovators are very successful in presenting their innovations and technologies. This paper deals with the topic of influence that technological innovation has on the company. The goal of the paper was to study the impact of innovation on the economy, especially on the development of enterprises and entrepreneurship. It starts with the conceptual definition of enterprise and entrepreneurship, the technology and the way that technology changes business, definition and characteristics of innovation as well as the impact of innovation on the enterprise in Croatia.

Keywords: innovation, technology, enterprise, entrepreneurship

1. INTRODUCTION

Creativity is a necessary prerequisite for change, but it is not sufficient in itself, because development and progress depend on inventive and enterprising individuals or entrepreneurs who will creative ideas push into the market. The world's largest producers are always afraid of losing market share. They are often under constant pressure to innovate, as the challenges facing businesses today are increasingly complex. Lack of investment in R & D greatly affects the competitiveness of companies because research and development are the key elements of successful enterprise innovation and the main source of competitive advantage on domestic and foreign markets. In the broadest sense, innovations include new products and services, new technologies, new manufacturing processes, new marketing methods, and new enterprise management models. The subject of this paper is the impact of technological innovations on the enterprise. The aim of the paper is to explore how innovations affect and develop business operations and entrepreneurship at all.

2. CHARACTERISTICS OF ENTREPRENEURSHIP AND INNOVATION TECHNOLOGY

The concept of entrepreneurship means not to wait for something to happen only from itself,

but to take action, even though the ultimate outcome. In Croatia, it means to be extremely brave, confident and passionate in achieving the goal. Entrepreneurship is the process of creating something new, either improving the existing or creating entirely new products, processes, etc. In this process of creating new values for different activities, the entrepreneur recognizes a new business opportunity, establishes and manages the enterprise, collects all the necessary resources for realizing business opportunities, product, overcomes the market, sells the product, distributes new value and recognizes a new business opportunity.

An entrepreneur is a person who takes on uncertainty and risk, a person who organizes and manages a company that has knowledge in marketing, finance, management, business decision making. The entrepreneur gained professional knowledge at school, which is not necessary because a huge number of today's entrepreneurs who succeeded in entrepreneurial waters are without formal education related to entrepreneurship and management.

Today's businesses are unthinkable without information technology (IT). Influencing and contributing to information technology is evident in the area of operations of business and employee control, internal and external co-operation, knowledge management, etc. It has enabled business activities to be improved by influencing the speed of business processes and cost reductions, because companies are much more organized to perform tasks with the help of various systems, most influencing the sale by allowing the Internet to offer its products directly to other companies on the business market and to end-users for sale. IT greatly affects the design of a new product, shortens the time and automates the production process, improves collaboration between companies with customers, partners, and so on. IT enables better co-ordination, teamwork, and problem solving in the company. Production works on method to reduce cost while simultaneously increasing product efficiency and quality, and IT is affecting excellence. “Allows for reduction of production costs and run the development phase. IT has enabled enterprises to benefit and progress as a result of the programming process of the production process, improved control, computer integration and greater flexibility. By networking, electronic data exchange, wireless systems have achieved better and better communication in enterprises”. [1]

2.1. Technological progress and enterprise entry into development and research

The main drivers of economic activity are generally innovative technologies so called: "Technology push" and "Market pull" innovation models. The "Technology push" approach includes new, improved, innovative products and process drivers for economic development or enterprise development. The main argument for the "Technology push" approach is that advances in basic scientific research are guiding the flow of innovative activities. Product innovations create new markets. "Technology push" approach is based on the positive influence between research development activities and inactivation, as well as the causal relationship between intensity and technological change. "Market pull" approach determines innovation as a result of influencing market demand. "Market pull" approach examines whether the technological change is a result of market demand or research development activities. A large number of research points to the positive impact of the market size on the company's inventive activity, but also on the fact that the growth of economic output is driven by the growth of investment in activities and innovations in the long run. [2]

2.2. Innovations

Innovations have been a driving force since the Stone Age and even today's economies in many countries and are key to the growth and development of modern enterprises. Enterprises that want to survive and be successful in the conditions of high competition must invest in development and introduce innovations. “By not introducing innovation forces companies to have

bad business results, lack of development, and leads to destruction by competition and the environment that effectively introduces innovations". [3]

2.3. Systematic innovation and seven sources of successful innovation

Systematic innovation means organized search for change, favourable opportunities for economic and social innovations that can be pointed out through changes. This means careful monitoring of the seven sources of successful innovation. The first four sources are in the field of business activities in companies, public service institutions and industry or service sectors. The other three sources of favourable opportunities for innovation include changes outside an activity:

- "Unexpected - unexpected success is the area that offers the most favorable opportunities for successful innovation and in this area opportunities have the smallest risk and the greatest satisfaction with success. This innovation source consists of unexpected success, unexpected failure and unexpected external circumstances.
- Incompatibility - is a symptom of a favourable moment for innovation. There are several types of disparities: the discrepancy between the economic realities of some industrial activity, the discrepancy between the actual state of an industry and the image that governs it, the disparity between the desire of an industry and the values and expectations of their customers, internal incompatibility in the rhythm or logic of a process
- Innovation based on the needs of the process - quite specific and exists within the process of the enterprise is not general and indefinite; it starts from the work that needs to be done, focused on the task rather than on the situation. This innovation sometimes makes it possible to establish a process by providing a missing link.
- Changes in the organization of the industry or the market - the uninterested ones are all interested. Changing the structure of an industry requires that all employees of this industry behave enthusiastically.
- Demographic Indicators - changes in population, age structure, composition, employment, education and revenue. These changes are measurable and their consequences are most predictable.
- Changes in perceptions, behaviour, and thinking - in taking advantage of these changes to introduce innovations, it is important to determine the best moment for some innovation and possibly be the first to introduce it. Due to the uncertainty and implications of introduction, conceptual-based innovation must be simple and specific.
- New knowledge or new knowledge - knowledge-based innovation is the star of entrepreneurship. The time span between the emergence of new knowledge and their application in technology is long because it takes a long time for new technology to become a product, process or service of market value and therefore innovations of this type have the longest empty strokes of all innovations." [4]

Knowledge-based innovations are expected to fail and are premature until all new knowledge is fully available and available. Innovations based on a smart idea are more numerous than all other categories together. These seven areas and sources of innovation are a large extent overlapping and the delimitations between them are very small. [4]

3. CROATIAN NATIONAL INNOVATION SYSTEM

Creating an innovation system in Croatia as a small country with limited resources represents the ability to create its own development, starting with the basic idea of National

Innovation System (NIS). “Under conditions where 90% of all available resources for development and research are concentrated in the ten most developed countries, the transfer of technology and knowledge from developed countries to developing countries is a natural solution for the acquisition and accumulation of their own technological abilities”. [5] The purpose of the NIS in Croatia is the strategic integration of technological, industrial and scientific policies into a new policy of economic development. Croatia has no choice to create cooperation between science, industry, government and finance and develop its innovation system. Creating technology abilities, innovation and use, and creative adaptation to other technologies should be the result of creating NIS. Croatia is in transition to modern society determined by the ability to manage technological change, the ability to innovate, produce new technologies or the creative transfer of foreign technologies. [5]

3.1. Encouraging examples of innovation in entrepreneurship in Croatia

INOVA is a traditional national exhibition of innovations since 1971. regularly maintains and shows the successes of Croatian inventive work. INOVA is the initiator and symbol of innovation in Croatia, and has so far brought together, inspired and made public thousands of Croatian and hundreds of innovations from abroad. The Croatian Association of Innovators has been organizing national exhibitions outside of Zagreb since 2003 and successful exhibitions have been held in Ogulin, Samobor, Rijeka, Čakovec, Osijek, Sibenik and Karlovac. “INOVA will be held this year in Zagreb in early November and is an opportunity to meet Croatian innovators and entrepreneurs with foreign counterparts and to launch innovation on the Croatian market. [6]

“Six companies from Croatia are at Deloitte's 500th fastest growing technology companies in 2017, led by Deliveroo from the United Kingdom. Companies from last year's list: Rimac Automobili, Hangar 18 and Gauss joined the companies in this year: Infinum, Nanobit and Code Consulting from Vukovar. Rimac Automobiles took 101st place, with a growth rate of 1059 percent, and Code Consulting found it at 229th with a growth rate of 545 percent. Growth for Hangar 18 was 368 percent, and they were at 321, and Gauss stood at 347 percent in 340th position. The growth of 315 percent of Infinum's business was enough for the 378th position on the list, and Nanobit's 430th place was 288 percent higher. The list of 500 fastest growing technology companies in the region, including Europe, the Middle East and Africa, has been creating the Deloitte Global Sector for Technology, Media and Telecommunications for seventeen years”. [7]

4. CONCLUSIONS

From all of the above it can be concluded that there is no simple formula for creating, introducing and applying, both technological and other innovations in enterprises, entrepreneurship and the entire economy. There is no recipe for simply transforming the economy from obsolete, inefficient and ruthless into a vigorous, lively and powerful economy that quickly adjusts to change, follows the market and trends, responds quickly and thus becomes knock-on and profitable. Development in Croatia continues there is still insufficient awareness of the need for a strong and rapid adaptation of the ways and structures of production to new technological and economic ways and requirements. The future of innovative Croatia is largely based on information technology technologies, which is evident from start-up examples - new companies with a completely different business model from the past, which are also proof that the situation. Company needs to create an atmosphere that will encourage creative and innovative ways to address the problems they face in their business.

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The Impact of Globalization on Further Development of Electronic Commerce

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Abstract

This paper explores the term of globalization as well as the concept of electronic commerce, and then examines the advantages, disadvantages, features and implications of globalization. The paper explores the role and impact of electronic commerce in the process of purchasing, selling or exchanging products, services or information, determining the benefits of e-commerce for retailers and customers as well as its disadvantages. Internet trade is considered to be the most profitable form of trade for simplicity and low cost, and as such will become a more significant and more powerful component of trade. Research in this paper is focused on the very concept of e-commerce, globalization, but also the shopping trend on internet. There will be examples of electronic commerce; Amazon.com and eBay.com. The aim of this paper is to show and explain the impact of globalization on further development of electronic commerce. During research of facts and possibilities that currently exist, for the formulation of the research results in this paper, the following research methods are used in a different combination: historical method, the method of analysis and synthesis, classification and description method.

Keywords: globalization, electronic commerce, internet, bather, seller, trade spread

1. INTRODUCTION

Globalization is not just a phenomenon or a transient trend, it is an international system that today encapsulates and shapes internal politics and international relations in almost all countries of the world and as such, it has to be understood and accepted.

The globalization system, which is the backbone of the paper, is not static but a dynamic process that is progressing and developing, has its advantages and disadvantages, these important features and implications. Globalization has already brought the unstoppable integration of national markets, states and technology, to a degree that has not been recorded so far in economic history. Globalization has enabled individuals, entrepreneurs, companies, but also states to reach all corners of the world, faster, deeper and cheaper than ever before. The basic driving force of today's globalization is the free market, because as economies open up more to free trade and competition, it will be more successful and dynamic.

Launching and running electronic business, especially the one in which the framework needs to conduct multiple transactions, requires new technology, business, marketing and management knowledge. Customers want access to products and services 24 hours a day, seven days a week, what is called the 24x7 principle. Companies that enable it, ie, providing the most trustworthy, most functional, the most sophisticated and fastest customer service will have the greatest chances for success [1].

2. GLOBALIZATION

Globalization is the process of economic, political, social and cultural activity at a

supranational level, ie a process that changes the established political, economic, social and cultural relations globally.

Often it is said that the globalization of economic activity with a related governance issue appeared only after the Second World War, especially during the 1960s. Then the period after 1960 marked the activities of multinational companies and the rapid growth of international trade. The collapse of Brett Wood's semi-fluctuating exchange rate system in the period 1971 – 1973 has really stimulated the expansion of investment in securities and auctioneers. Likewise, the capital markets and particularly the money markets have become internationalized very rapidly, increasing the complexity of international economic relations and announcing what is often seen as the globalization of an integrated and interdependent world [2].

Table 1. Positive and negative effects of globalization [3]

Positive effects of globalization	Negative effects of globalization
Greater civil and political rights	It brings great differences within the country itself
Less representation of corruption	It creates inequality and deepens it
Internet traffic of citizens	Spread of infectious diseases
Creating value networks and alliances	An increase in transnational crime

Globalization as well as every other process has its positive and negative effects on individuals, enterprises, states and supranational institutions, which can be seen in Table 1.

An important determinant of the globalization process is the technological development that allows the spatial and temporal reduction of the world. Indeed, the process of globalization has its own negative aspects such as the danger of creating an ideological concept that would impose universal standards in the interests of individual states.

Moreover, globalization today is an indisputable fact, it can not be removed from the system, nor neglected, it must be accepted and properly directed and shaped.

3. ELECTRONIC COMMERCE

Electronic commerce is broadly understood by the concept of electronic business, which includes electronic trading transactions, business partnerships, distance learning as well as a number of other activities through the computer network that improve the overall business of the company.

Electronic commerce can in principle be divided into two basic areas, that is trade between business entities - Business to Business or B2B as well as the trade oriented towards the final consumer market of everyday consumption, ie Business to Customer or B2C.

Table 2. Electronic commerce areas [4]

	Targeted to the final consumers	Targeted to the business consumers
At the initiative of business consumer	B2C (a business consumer to a final consumer)	B2B (a business consumer to a business consumer)
At the initiative of the final consumer	C2C (a final consumer to a final consumer)	C2B (a final consumer to a business consumer)

Table 2. shows the areas of electronic commerce, ie business models that are most important in electronic commerce.

The speed and extent of the acceptance of electronic commerce depend on the state and sector in which it is applied. The expansion of electronic commerce is not the same for all states, but Internet access is a common feature and a necessary tool for digital products.

Table 3. E-sales and turnover from e-sales, by firm size, EU, 2010 - 2017 (% of enterprises, % of turnover) [5]

	Enterprise with e-sales (turnover >1%) %			Turnover from e-commerce		
	2010	2014	2017	2010	2014	2017
All enterprises	13.3%	15.2%	17.8%	13.9%	14.8%	18.3%
Large (250+)	31.3%	35.3%	39.3%	19.1%	20.2%	25.7%
Medium (50-249)	19.8%	22.0%	25.5%	11.3%	11.1%	13.0%
Small (10-49)	11.6%	13.4%	15.8%	4.9%	5.8%	7.4%

Large companies are usually first which use the new technology and acquire an electronic philosophy. Likewise, there are no obstacles for small businesses to use the Internet for the same purpose as large companies, which in practice is not the case as evidenced by table 3.

The share of companies conducting e-sales and the turnover from e-sales varies significantly according to size.

The share of small enterprises making e-sales (15.8 %) is less than half compared to the share of the large ones (39.3 %). Even more striking is that the share of the e-sales' turnover on the total turnover by small enterprises (7.4 %) is less than a third of the share generated by the large ones (25.7 %) [5]. 25.5 % of medium sized enterprises made e-sales, corresponding to 13 % of total turnover in this size class.

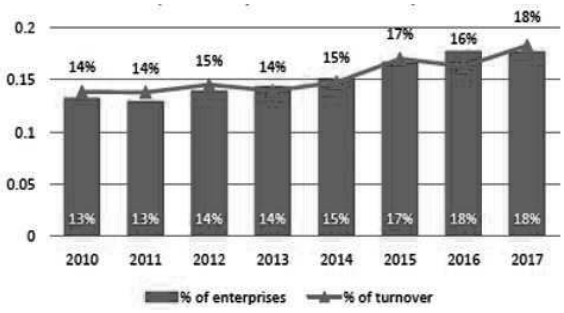

Fig. 1. Trends in e-commerce, EU [5]

One out of five enterprises in the EU-28 made electronic sales. The percentage of turnover on e-sales amounted to 18 % of the total turnover of companies with 10 or more persons employed.

In the EU-28, during the period 2010-2017, the percentage of companies that had e-sales increased by 5 pps and the companies' turnover realised from e-sales increased by 4 pps [5].

The opportunities of e-commerce have been largely exploited by Ireland, Sweden and the Czech Republic as it can be seen from the following figure.

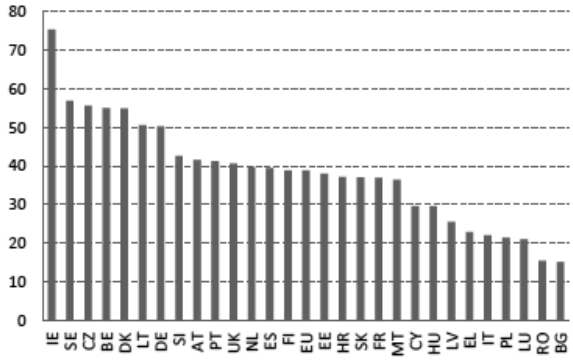

Fig. 2. E-commerce index [5]

SMEs in Ireland over-perform in all the e-commerce dimensions considered in the indicator. 29.5 % of Irish SMEs are selling online (more than half of them are selling cross-border). This helps them to generate nearly a quarter of their turnover (22.9 %) [5].

4. BENEFITS AND DISABILITIES OF ELECTRONIC TRADE

Electronic commerce its exponential growth and popularity owes to numerous benefits compared to classic trading methods. There are many advantages of electronic business that can be divided into benefits for buyers and companies and for the benefit of sellers themselves. On the other hand, when it comes to deficiencies, the sellers themselves by mismanagement caused some of the shortcomings, certain deficiencies have been created by the states and their legal regulations, while other shortcomings are attributed to the

failure to implement the modern marketing concepts.

4.1. The benefits of e-commerce for customers

Customers can compare their offer via catalogs that they receive by email or surfing the web pages. Shopping is simple and "private" - clients have less common problems and do not have to contact the sales staff and expose themselves to their persuasion. Business customers can be informed about products and services and buy them without waiting and losing time for additional conversations with sellers [6].

4.2. The benefits of electronic commerce for sellers

With the help of modern technology, an online retailer can choose small groups or individual customers, personalize his offer in response to their needs, and advertise such offer via direct communication. In addition, its clients can ask questions, but also give their opinion. Based on such interaction, companies can increase value for customers and their satisfaction through improving products or services. Using the internet for direct contact with business partners companies reduce costs, which ultimately leads to savings for customers.

4.3. Disadvantages of electronic commerce

The disadvantages of electronic commerce from the position of e-commerce owners are usually the costs of equipping electronics stores for efficient and secure business as well as the lack of staff qualified for quality management of electronic commerce.

On the other hand, disadvantages of electronic commerce from the e-commerce user's position are; there are doubts about safe internet business and e-transaction security, as well as the need to check the seller's quality and experience and the credibility of the information provided. As a disadvantage, potential privacy threats may also be taken into account for collecting data on customer preferences, as well as the possibility of errors about data entry, delivery of ordered goods and similar.

5. ELECTRONIC TRADE IN THE WORLD

With the expansion of globalization, e-commerce has grown from year to year, and the internet is becoming increasingly present in market operations. Of course, the speed and extent of e-commerce acceptance depends on the country and the application sector. The US is the leading country in the area of electronic commerce, where the total internet trade exceeds billions of dollars, and in the future is expected to be even more profitable in the same way. The best known and most common internet stores in the world are Amazon.com and eBay.com that will be displayed below.

5.1. Amazon.com

Amazon.com is an American Internet commerce based in Seattle. The first product sold through electronic commerce was a book and it happened through Amazon.com. Amazon.com was founded in 1994, and initiated in 1995 by Jeff Bezos.

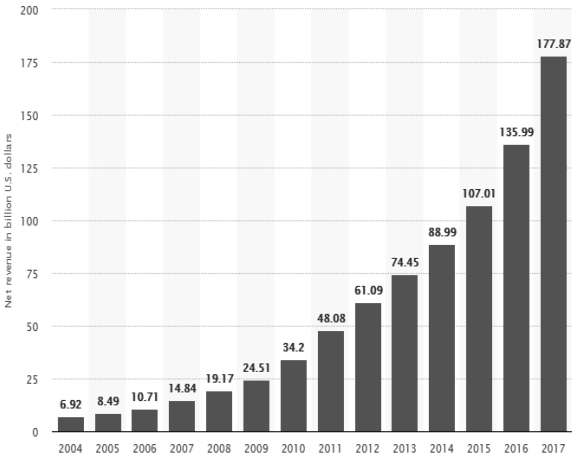

Fig. 3. Net sales revenue of Amazon from 2004 to 2017 (in billion U.S. dollars) [7]

The figure 3. shows the net revenue of Amazon.com's e-commerce and service sales from 2004 to 2017, in billion US dollars. In the last reported year, the multinational e-commerce company's net revenue was almost 178 billion

U.S. dollars, up from 135.99 billion US dollars in 2016. More than 50 percent of Amazon's revenue were generated in electronics and media.

5.2. eBay.com

eBay is the largest worldwide auction internet platform for sale. It was founded in California in 1995 by Pierre Omidyar in San Jose (California) under the name Auctionweb. Shortly after its establishment, platform is developing into a place to buy and sell new products, used items, rarities, collecting items, books, automobiles, etc. [4].

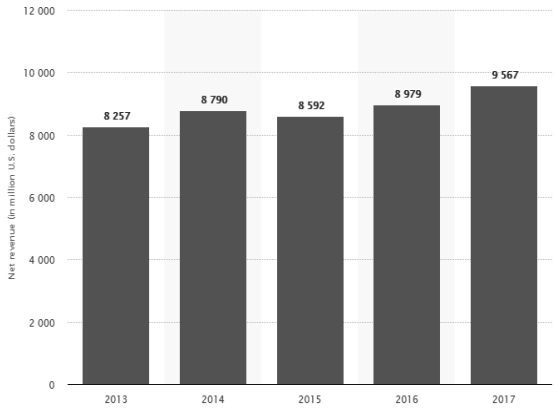

Fig. 4. eBay's annual net revenue from 2013 to 2017 (in million U.S. dollars) [8]

The figure 4. shows the annual net revenue of eBay from 2013 to 2017. In 2017, the online auction and selling website's net revenue amounted to close to 9.7 billion U.S. dollars, up from 8.99 billion U.S. dollars in the preceding year. The majority of eBay's revenues are generated via marketplace transaction fees.

6. IMPACT OF GLOBALIZATION ON THE FURTHER DEVELOPMENT OF ELECTRONIC COMMERCE

Today's borders between the states represent a far smaller obstacle than it was before. The weakening of the border can be partly due to technology, but also to international, bilateral agreements, especially in the field of trade. The world is increasingly becoming a place without borders, or the customs disappear in parallel with the knowledge of many states that they need each other to survive economically. The boundaries, of course, are not completely gone, as nation-states still have a reason to control the movement of goods and people in accordance with the needs for state security, but taking into account the four key factors of business life - communications, capital, corporations and consumers, the world has, in many ways, become a place without borders.

What the world really has set aside is the development of the internet that began in the mid-1990s, which continues to this day. This is a technology that is available to many and widely accessible everywhere by personal computers and mobile devices. Through the Internet, there is a trade turnover for which the borders have disappeared.

Advances in telecommunications for many companies meant that they no longer have to be related to the company's center in a particular city. If the circumstances so required, they could also separate themselves from their place of origin in legal terms and move to a more favorable location [9].

In the modern, developed economies, the share and significance of exports in industrial production is increasing. Countries that direct most of their production to the world market, or which have export-propulsive and not import-substitute growth, are developing faster. From this, it can be concluded that the globalization of the world economy has brought untapped pole to foreign trade and that it carries a trend that is constantly progressing.

7. CONCLUSIONS

Globalization represents the process of uniting the world into one entity or system. Because of the overall ongoing information and communication technology advancement, the world became mutually integrated. Internet commerce is no longer something that needs to be developed, it is already there, deeply integrated into everyday consumer behaviour, and the only question is which extent domestic

companies will know how to use, and how much the foreign companies will use what is provided. Electronic commerce is one of the fastest growing branches of the economy, and all indicators show that this trend will continue as merchants can no longer ignore the internet as a sales channel so many will have to redirect their businesses exactly to virtual markets. While e-commerce is naturally evolving through an entrepreneur's initiative, driven by market needs and easier final-user access, this form of trading largely depends on the confidence of entrepreneurs and consumers in the security of electronic transactions.

Interestingly, just over a dozen years ago, in most countries, very few people used the Internet, and today the Internet is considered as the common and unavoidable infrastructure of every citizen irrespective of the age or level of education, so of course it will be expected that e-commerce will continue to move upward. Electronic commerce therefore has a handful of potentials that need to be utilized. For many businesses, the digital era will mean searching for a new model of practice and marketing strategy, as the internet brings a change in thinking and the way values are created. Merchants will have to adjust to change in order to survive under the new conditions that are determined by technology and the development of globalization.

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Innovation for the Brave

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Abstract

In today's business world there can be no progress if there are no innovations, advancements, and investments in business. In this paper, companies are encouraged to introduce eBusiness which is supposed to help increase sales, improve the business, attract new customers while keeping the old ones, and reduce the expenses. By implementing these improvements, the company would be ahead of the competition. As an example of this, Mozart Fast Food were advised to develop an app since they are usually very beneficial for the customers and easily attract new ones. They were also advised to introduce a hologram into the kitchen so as to improve the food production, and to use a drone as a way of delivery which would significantly reduce the expenses. Using these innovations, the company should shorten their delivery time and improve their service. Faster food delivery and shortened production process are supposed to ensure a faster, higher quality service. This means more work could be done and all of it would be done with lower costs and a better quality. This way the company will expand its business a new market and easily outrun the competition.

Keywords: innovation, e-business, hologram, Mozart application, drone

1. INTRODUCTION

In this paper eBusiness is proposed for the Mozart Company, as a way to increase the sales, lower the costs, attract more customers, and expand onto a new market, which is something every company has as a goal. Mozart app, hologram, and a drone would bring with them new possibilities while at the same time reducing the costs.

The purpose of the paper is to encourage the Mozart Company to introduce eBusiness to increase sales, reduce the costs, attract new customers, and help find ways to deal with problems that might come up while introducing eBusiness.

Hypothesis:

- introducing the Mozart app will enhance the business, reduce the costs, save time, and make ordering more accessible for the customer
- introducing holograms makes orders more manageable for a chef
- introducing drone delivery lowers the costs and improves the delivery

2. E-BUSINESS

"E-business is the use of information and communication technologies (ICT) as support for business activities. E-business enables businesses to combine business processes and thus significantly simplify customer relations and suppliers. "[2] “With e-business, companies earn more money and save time using the latest technology. E-business needs to be steadily invested in order to improve the organization's competitiveness, expand its market, and increase the number of customers.”[4]

"The way the e-business takes place is changing rapidly because of new developments resulting from technological changes, so MSPs can not ignore new trends and opportunities that can increase their competitiveness, for example:

- use of social networks to find customers
- Use of video games for various purposes, from marketing to training
- mobile applications
- Cloud computing
- processing of goods and inventory in real time" [2]

With e-business, companies can communicate, promote, get business information, conduct online sales and trade, pay bills via Internet banking, work with state bodies, such as paying taxes through Internet banking. E-business enables companies to earn more, saving money and time using ICT, especially the Internet, the world's computer network. It enables companies to merge business processes, create information, and streamline data and documents into a single business entity together with suppliers and partners. It also increases the quality and meets the expectations and needs of the customers.

For small companies this will be simpler because big companies have more complex business. Better market competitiveness enables the Internet by increasing the availability of information and purchasing opportunities, thus creating equal market opportunities for smaller companies. The Internet makes all segments of business activity.

„ Some of the benefits of e-business are:

- improving internal communication between departments through the company's web portal
- use of inexpensive models for business marketing such as social networks or Google marketing tools
- search for business web portals in order to find valuable information
- the use of established internet shops such as Amazon or auction sites such as eBaya
- tracking shipments, tracking stocks" [2]

An online store, also known as e-store, web shop, e-commerce, virtual shop, is becoming a huge and ever-growing part of e-business. This allows consumers to purchase and sell goods or services over the internet. "E-commerce is a branch of e-business that uses the Internet as a media for the implementation of transactions - the purchase, transfer or exchange of goods, services and / or information over the Internet. An example of e-commerce is a web shop." [2]

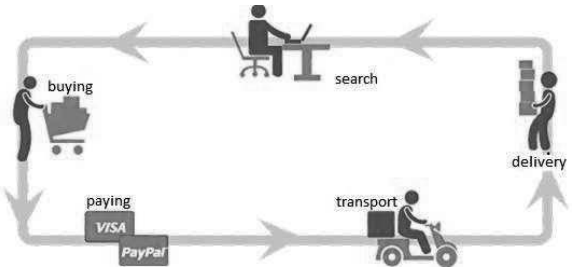

Fig. 1 eBusiness process [3]

Figure 1 shows the e-business process that takes place cyclically, ie all actions are circular one after the other and are repeated. First, the internet search for the desired product is followed by selection and purchase, after which the product is paid online, then the transport of the selected product to the customer and the delivery. Through the Internet, the package consignment monitoring is enabled, ie the consumer can check where his shipment is located by means of the packet code so that the e-business process takes place cyclically.

3. INNOVATION FOR THE BRAVE

Introducing eBusiness has been suggested as a way to increase sales and reduce the costs, as well as to attract new customers and expand the business.

Namely, using the Mozart app, holograms, and drones are only some of the ways to lower the overall costs and subsequently increase the sales.

The first idea is to create the Mozart smartphone app which would enable the customers to order the food quickly and easily. The Mozart Company and its app would have to be advertised on social media and its own

website, with clear instructions on how to use it and why it is beneficial.

The app would allow customers to go through the menu and in a simple tap order a meal tailored to their wishes. The customer would also get feedback and would be given the option to track the location of their order.

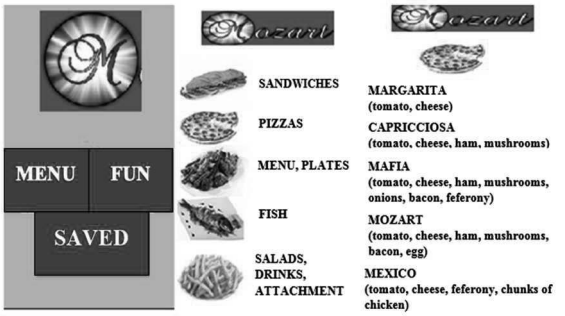

Fig. 2. Mozart application [4]

Upon opening the app, one can choose between 'menu', 'entertainment', and 'saved'. There are numerous games under the 'entertainment' tab and by playing them, customers can collect points which promise discounts or even free food packages. A single tap on a saved order allows for a quick and easy order. Choosing 'menu' opens up the entire meal list (sandwiches, pizzas, meat, fish, salads, side dishes, drink) and a tap on, for example, a pizza as shown in fig 2 displays the varieties of pizza toppings offered by Mozart. Finally, a customer places an order.

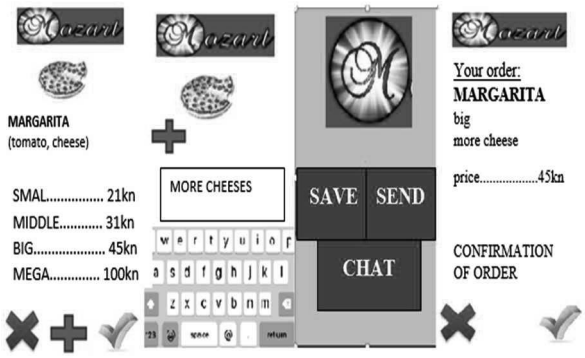

Fig. 3. Mozart application II [4]

When a customer chooses the kind of pizza they want, they can also choose the size they want and are informed about the price. Changes can be made by tapping on the red 'X' at the bottom, and tapping on the blue '+' allows to add new items, as shown in fig 3 with the 'extra cheese' addition. Green check mark confirms the order. Tap on the 'OK' gives a choice between 'save', 'send', and 'Chat'.

Order can be saved with 'save', and 'Chat' allows a customer to leave a comment and give feedback about the service. This option gives the company valuable information which can then be applied to enhance the service experience. 'Chat' offers tracking the order by tapping on the 'track' The 'send' option opens the order and a customer can now choose either to confirm it (green check mark) or to remove it (red 'X').

This smartphone app would also serve as a cash register for the waiters, and thus would allow for easier and faster orders, which are then automatically sent onto a hologram located in the kitchen. This would also mean there is no need for the waiters to go into the kitchen.

They receive the signal (a message) via the app when the order is ready. This means the food will be served faster because the waiter is not going back and forth to check whether or not the meal is ready.

The hologram is conveniently located in the kitchen for the chef and the staff to receive the order as soon as it is placed.

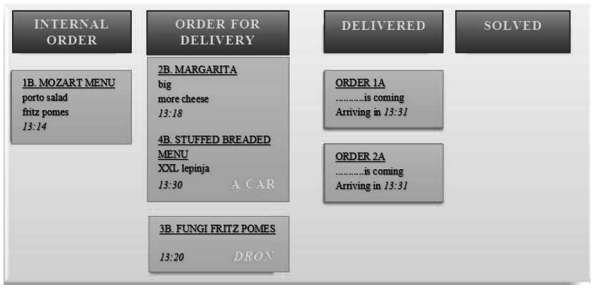

Fig. 4. Hologram [4]

Hologram would be connected to the Internet and would put similar orders together (with similar addresses, in cases where they can be delivered at the same time or in the same way). It would also put some orders above others if they fit well with the earlier ones. Fig 4 shows how the order 4B was placed above 3B because the orders 2B and 4B are at nearby addresses. This lowers the costs and ensures a faster delivery. The

hologram also shows when the delivery should be made, and which ones have already been made (when they do so on time and without problems). It follows the traffic and calculates whether it makes more sense to deliver with a car or with a drone. When there is a traffic jam, the hologram will suggest using a drone, but it will also inspect the weather and if it is raining, snowing or if it is windy delivery by car will be recommended. It weighs the package as well because a drone cannot handle a heavy one. The weight of each item is saved in the main PC.

After the delivery is made, the drone sends a signal and it is saved onto the hologram as delivered, and at the same time the customer is informed that their order has arrived. The notification about the delivery stays on the hologram for the next ten minutes, and later all of the orders made during the day are listed and accounted for. The drone delivery is made possible by the online banking in the Mozart app. Hologram checks if there is enough money to cover the cost if the delivery and it charges once the delivery has been made.

If the drone is used in cool weather, Styrofoam food containers are used because of their light weight suitable for drones and because they provide enough isolation to keep the food warm.

4. CONCLUSIONS

The Company was suggested to upgrade the website, advertise the service on social media, and enhance the business with the Mozart app. Another idea was to implement a hologram into the kitchen and a drone as an alternative delivery system, all to contribute to a faster and a higher quality service. The paper explains how the Mozart app works, as well as how it cuts the expenses and saves time, while making it easy for a customer to place an order. All of this proves the first hypothesis.

Considering the way, the hologram functions, it is clear that it would make it easier for a chef to manage the orders quickly and with easy, thus saving time and bettering the service. It ensures an order is on time which proves the second hypothesis. Drone delivery would reduce some of the costs and make delivery more efficient, which confirms the third hypothesis. Hologram is the one that helps decide whether a drone or a car delivery is optimal in a given moment.

The Mozart Company would grow after implementing eBusiness, would expand its business and the service might appeal to a great number of customers who appreciate simplicity and quick deliveries. All this would ensure Mozart stays ahead of the competition.

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Importance of Innovations in Business Ecosystem

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Abstract

Innovations today take a very important place in all business segments, and the business ecosystem is one of the most important drivers for development and promotion of innovations. In addition, business ecosystems have a key role and critically important implications for society, economy, technology progress and business activities, therefore innovation represents a driving mechanism to achieve success in these areas. Establishing an effective system for encouraging and promoting innovations is an important task, which requests a lot of effort and commitment, and connections with external and internal factors of innovation. Also, to achieve this goal, business ecosystem needs to provide different resources in the form of capital, partners, suppliers, and customers to create cooperative networks and appropriate business models. The aim of this paper is to show that business ecosystem promotes innovation process to strengthen its position and creates a sustainable environment that enables its development in a positive direction.

Keywords: innovation, business ecosystem, sustainability, technology progress, benefits

1. INTRODUCTION

Modern business is faced with the challenge of constant innovation in order to be sustainable and to further develop. One way of strengthening the companies as a whole is their functionality within the established business ecosystem, which should encourage innovation and facilitate the entire business operation of companies.

In order to strengthen, a business ecosystem in modern business conditions should thrive to direct the road to their development, which includes support for overcoming the barriers that appear on that path. One of the biggest challenges that follows the process of company development through innovation is the introduction of modern technologies.

Companies become embedded in interdependent relationships with other institutions and organizations, and this is foundation of business ecosystem.

Moore defined business ecosystem as "extended system of mutually supportive organizations; communities of customers, suppliers, lead producers, and other stakeholders, financing, trade associations, standard bodies, labor unions, governmental and quasigovernmental institutions, and other interested parties. These communities come together in a partially intentional, highly self-organizing, and even somewhat accidental manner"[1]. This definition highlights decentralized decision-making and self-organization as a model for achieving business success.

In view of ecosystems as meta-organizations that "resemble biological super-organisms, a multitude of individual organisms that coexist, collaborate, and coevolve via a complex set of symbiotic and reciprocal relationships, which together form a larger organism" [2].

Business ecosystem is very complexity whole, whose complexity stems from the

diversity of relationships, the number of diverse relationships, and the resultant interdependencies [3].

The performed roles of each business entity and relationship between them inside the business ecosystem are established in order to provide an overview of their involvement in cooperation process and business ecosystem performance [4]. Relationship between them should be dynamic and adaptive, with characteristics of complexity. Like organisms within the biological ecosystem, business ecosystem entities must constantly adapt to changes in the given system, as well as the rules that apply to it. Certainly the most important adjustments relate to the process of innovation that is constantly present within the business ecosystem. One of the basic features of the change is their dynamism, which is also one of the basic characteristics of business ecosystems.

"Like an individual species in a biological ecosystem, each member of a business ecosystem ultimately shares the fate of the network as a whole, regardless of that member's apparent strength"[5].

It is important to emphasize that business entities direct each other within the business ecosystem, towards implementation of innovations and provide support through this process.

Today's business can not be imagined without the implementation of innovations within it. According to Schumpeter innovation can be explained „as process of introducing a new product or modifications brought to an existing product" [6]. Tidd &Bessant state that „ Innovation is driven by the ability to see connections, to spot opportunities and to take advantage of them" [7]. The European Commission defined innovation as: „Successful production, assimilation and exploitation of novelty in the economic or social environment" [8]. Very important role in modern business has technological innovation. OECD gave the next definition of technological innovations: "Technological innovations comprise new products and processes and significant technological changes of products and processes. An innovation has been implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation). Innovations therefore involve a series of scientific, technological, organizational, financial and commercial activities" [9].

Sharing experience of business entities through business ecosystem in domain of innovation, has an immeasurable significance, both for the concrete subjects which implement the process of innovation and for the business ecosystem as a whole. That is certainly reflected in the strengthening of the innovative activity of whole society where this ecosystem functions. The role of business ecosystem is also to provide knowledge for entrepreneurs, innovative companies and policy makers in the area of innovation.

2. METHODS AND MATERIALS USED FOR RESEARCH

In order to present possibilities for innovation and their significance for business ecosystems, we performed a literature review. For this purpose, we have used academic and management literature and other open sources on internet, therefore we have investigated a number of articles and research which are relevant to this topic. The work was based mostly on conceptual analyses.

3. ACTORS OF BUSINESS ECOSYSTEM AS DRIVERS OF INNOVATIONS

Business ecosystem operation is determined to a large extent by the participants in it. Modern trends indicate the need for continuous improvement in all segments of the business ecosystem and at all levels. It is understood that business ecosystem is a very complex entity, within which a thorough interpretation of the existing relationships and connections between

the participants is necessary. It is also necessary to consider adequately their flexibility and readiness to adapt to changes in the internal and external environment, which directly influences the implementation of innovations in given business ecosystem.

The term business ecosystem was introduced by Moore, who also defined its participants.

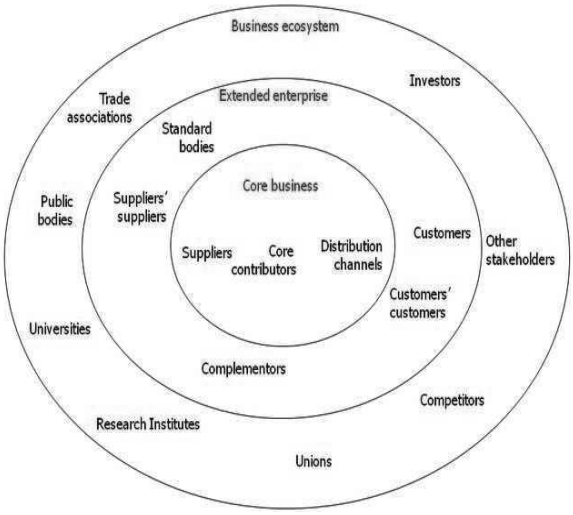

Fig.1. Participants of business ecosystem according to F. Moore[10]

Business ecosystem is a developed system from organizations which protect each other [11]. Each member of this concept influences and contributes to its functioning and it can be said that in this way affects of the whole business ecosystem destiny. The participants recognised that in the ecosystem composition phase, it is important to confirm the involvement of a broad spectrum of actors, while membership dynamics (i.e., entry and exit of actors) were emphasized in the orchestration phase [12]. The actors include the material resources (funds, equipment, facilities, etc.) and the human capital (students, faculty, staff, industry researchers, industry representatives, etc.) that make up the institutional entities participating in the ecosystem (e.g. the universities, colleges of engineering, business schools, business firms, venture capitalists, industry-university research institutes, federal or industrial supported centers of excellence, and state and/or local economic development and business assistance organizations, funding agencies, policy makers, etc.) [13].

Relationships between actors proved to be the primary mechanism for managing in the business ecosystem [12]. Organizational activities are now happening in specific eco-systematic space, competition is between business ecosystems not organizations and it is necessary to consider changes in business environments to be success in this space, to make changes in minds to be prepared for these variations, even sometimes move beyond and make these changes [11].

According to Deloitte analysis "business ecosystems are dynamic and co-evolving communities of diverse actors who create and capture new value through both collaboration and competition" [14]. Ecosystems typically bring together multiple players of different types and sizes in order to create, scale, and serve markets in ways that are beyond the capacity of any single organization—or even any traditional industry. Their diversity—and their collective ability to learn, adapt, and, crucially, innovate together—are key determinants of their longer-term success [14].

All participants in business ecosystem should have focus on creating and delivering customer value. Business ecosystems need to help startup entrepreneurs and incumbent businesses and collaborate more effectively, especially in introducing new innovations. Balancing collaboration and competition with a broad range of ecosystem actors is central to engage in cross-cutting innovation [15]. Ecosystem actors have many reasons to stay together or actively participate in the orchestration of their ecosystem [16].

Innovations by ecosystem actors tend to use novel technologies, modern and flexible business models. This should lead to the development of the entire business ecosystem and enable the sustainability of all actors within.

Actors in the business ecosystem are faced with great challenges that must be successfully managed, so that the ecosystem can survive. In

order to achieve this successfully, a greater commitment of all participants and good communication between them is necessary.

3.1. Dimensions of business ecosystems

According to Gartner, we can distinguish 8 dimensions of business ecosystems [17]:

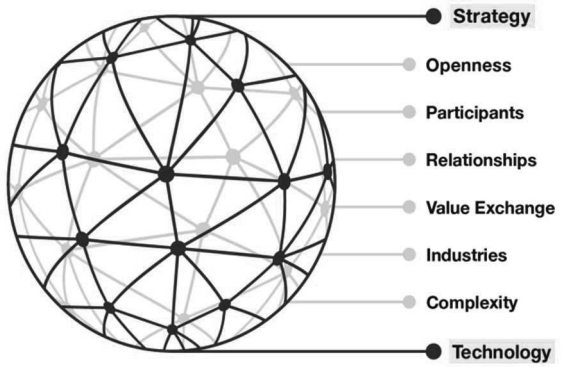

Fig.2. Eight dimensions of business ecosystem

- One of important requests for business ecosystem is to choose appropriate strategy, and this affects individual players on the roles that will be selected within that business ecosystem as: leader, disruptor, niche player, orchestrator, or something else.
- The degree of openness within ecosystems is driven by strategies, common goals and shared interest. An ecosystem may be public, private or a hybrid. Many organizations actually participate in a hybrid of public and private ecosystems.
- Today, participants in business ecosystem need to figure how to integrate new technologies, things such as: smart advisors and artificial intelligence.
- Modern platforms provide new possibilities for business ecosystem such as: integration, application and management services. Platforms connected participants with different goals and objectives and support mediating in relationship in ecosystem.
- Ecosystems enable companies to exchange products and services for information or analytics. It's important to understand the changing definition of "value" that ecosystems create.
- Ecosystem expansion can result in unexpected partnerships for organizations. Partners could include organizations within the primary industry, adjacent industries or, most unexpectedly, far-neighbor industries outside of the business's industry (i.e., travel and healthcare).
- Large organizations will most likely be involved in multiple ecosystems. The key is to understand how these ecosystems interact, identify potential fractures and overlaps, and acknowledge constraints and implications.
- In modern business conditions, success requires a strategic integration of technology, information and business processes. Organizations that do not work toward understanding their business ecosystems risk falling into a participatory role only, enabling other competitors or partners to take the leadership role and thus define the rules for engagement in that ecosystem. The main people of companies or CIOs are responsible for the technology that will enable the business ecosystem strategy now and in the future.

4. RELATIONSHIP BETWEEN INOVATION AND BUSINESS ECOSYSTEM

Today, innovation is, more than ever, generated by the interrelation and convergence of many participants within an business ecosystem. All participants in business ecosystem participate in the process of moving innovations from discovery through commercialization, and in this way comes the creation of an innovative ecosystem. It is very important to provide support by all stakeholders for all innovation activities carried out within the ecosystem. Author Jackson defined innovation ecosystem as " the complex

relationships that are formed between actors or entities whose functional goal is to enable technology development and innovation" [18].

Some of the main tasks for entities in innovation ecosystem are [19]:

- Gathering of the right people involved in the ecosystem
- Cultivating the network
- Educating others participants.

Innovation ecosystems integrate exploration (knowledge) and exploitation (business) ecosystem. Business and innovation ecosystem are two very connected terms, with some differences [15]:

Table 1. Different type of ecosystems and their characteristics

	Business Ecosystems	**Innovation ecosystem**
Baseline of Ecosystem	Resource exploitation for customer value	Co-creation of innovation
Relationships and Connectivity	Global business relationships both competitive and co-operative	Geographically clustered actors, different levels of collaboration and openness
Actors and Roles	Suppliers, customers, and focal companies as a core, other actors more loosely involved	Innovation policymakers, local intermediators, innovation brokers, and funding organizations
Logic of Action	A main actor that operates as a platform sharing resources, assets, and benefits or aggregates other actors together in the networked business operations	Geographically proximate actors interacting around hubs facilitated by intermediating actors

Table 1. summarizes the differences between business and innovation ecosystems in terms of their outcomes, interactions, actor roles, and logic of action. These two types of business ecosystem are dynamic, changing and also changeable through ecosystem orchestration. Implementation of innovations in each system leads to uncertainty and major changes, so their rapid acceptance and implementation is very important for healthy functioning of the whole ecosystem.

5. CONCLUSIONS

The future of business ecosystems will be largely conditioned by their flexibility, degree of complexity, co-operation of their actors, and, of course, readiness to accelerate innovation. Business ecosystems will enable next-generation value chains and new sources of innovation, while driving demand for new skillsets [20].

Companies in business ecosystem need to be in state of constant adaptation as they innovate and develop new products and services. It is essential for the ecosystem leader to understand what possibilities exist to guide other actors to achieve the expected product or product idea [21]. As with biological ecosystems, business ecosystems need permanent care of its actors, in order to ensure its sustainability in the condition of uncertainty.

The importance of innovation can be seen especially in current digital revolution, where changes are taking place faster than ever before. Most innovations relate to changes in technology which will play a significant role in enabling the ecosystems of the future. In the age of the knowledge economy and rapid change, successful economic development is intimately linked to capacity of existing business ecosystems to generate, acquire, absorb, disseminate, and apply innovation towards advanced technology products and services. Due to the large number of possibilities which exist in modern societies, creation of new business ecosystems is necessary. Their role in these societies is of great importance for further development and efficient implementation of innovations as an indispensable part of this development process.

6. ACKNOWLEDGEMENTS

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The Evolution of Localized Industrial Clusters into Innovative Global Networks

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Abstract

The current turbulent market leads to growing customer and stakeholder demands. Therefore, companies, especially Small and Medium enterprises (SMEs) tend to establish collaborative environment in order to cope with these challenges and achieve desired market position. Some of the challenges facing SMEs are the lack of resources and less skilled personnel. Networking could help them to overcome these barriers, then to increase their productivity and to improve the competitiveness in the market. One of the most effective forms of business networking is an industrial cluster, which aims to increase the productivity with which companies can compete on the national and global market. Since industrial clusters enable resource, knowledge and information sharing among their members, they have become an essential part of dynamic and complex business environment that provide work force specialization, companies grow and national economy development. The purpose of this paper is to examine how cluster competitiveness increases in terms of improved innovative activities on the global market that are characterized by collaboration based on the triple helix model.

Keywords: industrial cluster, innovation, networking, value network

1. INTRODUCTION

The last few decades in the business literature are characterized by collaboration and partnerships among organizations, strategic alliances, networks, inter-organizational cooperation and cross-sector partnerships among organizations. New business models and paradigms motivate researchers to look in the cooperation issues in different ways. Also, new technologies bring a lot advantages to process of collaboration among organizations, especially ones that operate in the virtual environment.

This paper has aim to examine how cluster competitiveness increases in terms of improved innovative activities based on the triple helix model and supported by new technologies.

In the next chapter, it will be examined literature on the topic of whole networks, which explains how results and outcomes of collaboration within network can be managed and generated. Third chapter includes the literature review on the position and role of industrial clusters in the networked business environment. Then, in the fourth chapter is examined influence of advanced technologies on the process of evolution of local industrial clusters into global value networks. In the end, authors made conclusion remarks on the discussed topics and defined implications for the future research.

2. WHOLE NETWORK THEORY

Many authors have examined networks in the context of organizational and social networks rather than examining whole network. Whole network theory explains how networks evolve during the years, how they are explained to

stakeholders and how results and outcomes might be generated [1]. Brass et al. (2004) defined a network as "a set of nodes and the set of ties representing some relationship, or lack of relationship, between the nodes." [2].

Authors, who examine organizational networks, prefer to write about partnerships, cooperative arrangements and business deals, inter-organizational relationship, strategic alliances, value constellations, etc. [1], [2], [3]. During the research on the topic of organizational or business networks, all aforementioned terms need to be used as a keywords, otherwise research may result with partially explored literature on this topic. Organizational networks are only one part of whole network theory, it covers wider range of network aspects.

Whole networks can be observed from two different points of view: the view from the individual organization and the view from the network level of analysis [1]. Some other authors also make distinction, they view networks on the micro and macro level [3] or as egocentric network via the whole network [4].

Whole network has a task to review and analyze inter-organizational networks at the network level of analysis. Understanding this concept can help authors and researchers in the process of understanding and observing global value networks.

Dynamic business environment creates such conditions where is not enough that SMEs and cluster operate on the local level, but it is necessary to evolute in global networks.

Both the cluster and global value network approaches are oriented towards upgrading in order to achieve competitive position on the market. Both approaches emphasize importance of governance and research institutions in the evolution from local organizations to become a member of global business networks.

3. INDUSTRIAL CLUSTERS IN THE NETWORKED ENVIRONMENT

Nowadays, cluster need to become visible on the international market and to be globally recognized. Cluster Excellence organization[1] awarding cluster organizations which achieve positive business results and which are committed to continual improvement in terms of the cluster structure, governance, financing, strategy and services.

Small companies within the cluster perceives the possible benefits of local knowledge, resources, technologies, equipment. There are a large number of literature that provide explanations and reasons why SMEs need to operate in the networked environment.

Much of the early literature concerned the importance of localized industrial clusters and their benefits to SMEs and local economies. However, the recent literature concerns not only importance of local operations but focus is put on the global market and SMEs internationalization and visibility.

SMEs have advantages in terms of flexibility, reaction time, and innovation capacity that make them central actors in the new economy. In this complex business environment, SMEs must develop themselves strategically in order to remain growth, competitiveness, and prosper [5].

3.1. From local to global: evolution of SMEs and clusters

The word "global" has now become key word in the business and economics. Many authors seen particular region, continent or even whole world as a one market. Therefore, it is necessary to understand advantages and disadvantages of the process of SMEs and cluster globalization. Figure 1 presents product and market development before globalization.

[1] European Clusters Excellence, available at http://www.clusterexcellence.org

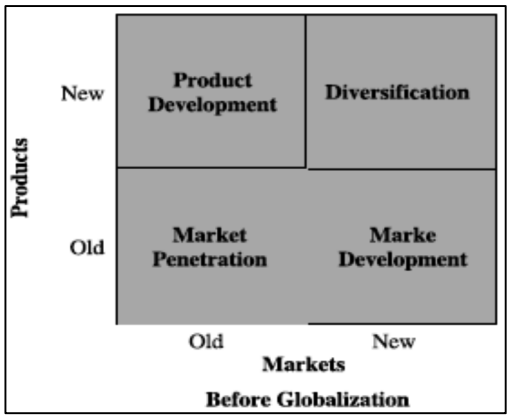

Fig. 1. Vectors for strategic development of manufacturing companies before globalization [6]

Before globalization focus is put on the product development and diversification. [6] Companies were striving to place new products on the new markets, still operating more locally than globally.

Due to dynamic business changes and globalization, market has become more open for external parties. [6] Market became global and companies start to change their business philosophy. Figure 2 presents strategic view of market and products after globalization.

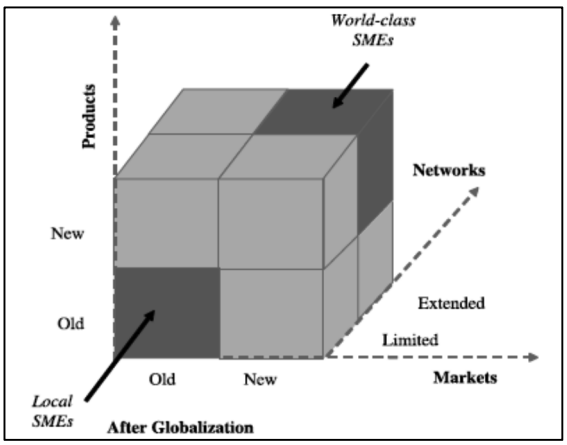

Fig. 2. Vectors for strategic development of manufacturing companies after globalization [6]

After globalization local SMEs become part of global networks together with world-class SMEs. Strategic decision to become part of a network comes from their perspectives and performances that they have been developed through years. [6]

One of the prerequisites for a company's successful process of globalization is its collaboration and networking with participants through the entire value chain. Such kind of networking in the literature is termed as value network. Value network can be defined as *"any set of roles and interactions in which people engage in both tangible and intangible exchanges to achieve economic or social good"*. [7] This concept is based on the cooperation among various participants, e.g. universities, research institutes, companies, government bodies, in order to achieve their own objectives and the common objective on the network level as well. This kind of cooperation in the literature is recognized as Triple helix model.

3.2. Triple helix model

Triple helix model represents innovative environment based on science, technology and an entrepreneurial initiative. This model enables companies and industrial cluster to emerge around new technologies and operating globally. [8] Model is based on the cooperation among government, industry and research institutions (Figure 3).

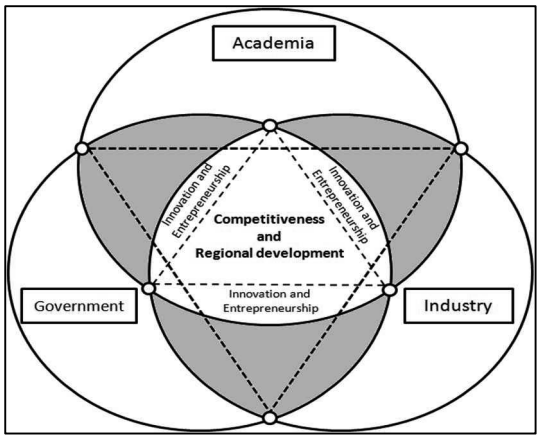

Fig. 3. Triple Helix Model: cooperation among government, industry and research institutions *[8]*

Triple helix model helps researchers and practitioners to understand the importance of innovation, cooperation and dynamic interaction among different network participants which should result in increased competitiveness and regional development.

Due to rapidly development of networking technologies, cooperation among aforementioned participants goes beyond local,

geographically closed markets. Global market now seems to be very close and companies and clusters begin to recognize advantages of running business on the global level.

Although, triple helix model is not new concept, it is still topic of many studies and discussions, especially when it comes to less developed regions and countries.

In the literature, it can be found upgraded model called *quadruple helix model*. This model is expanded by new category, society. Leydesdorff & Etzkowitz (2003) stated that each helix represents specialization which evolve from and within civil society. [9] This model has a number of advantages, but one disadvantage is related to its subjective preference of the fourth helix. [10] Most economies, especially ones in less developed regions, still is using triple helix model in order to avoid

4. NEW TECHNOLOGIES TOWARDS INDUSTRIAL CLUSTER GLOBALIZATION

For the effective functioning of the Triple Helix model in the global cluster environment it is necessary to use advanced networking technologies, especially one in domain of innovative software-defined networking. Using this type of technology means solving some market challenges and could be used in creating efficient business solutions.

Nowadays, workplaces have become more and more virtual and the key enabler for all virtualizations is the Internet and various computer networking technologies, such as Cloud Computing and Cloud Networking [11], [12]. Cloud computing can be explained as clusters of distributed computers (largely vast data centers and server farms) which provide on-demand resources and services over a networked medium (usually the Internet). [13]

Cloud networking closely relies on the concept of cloud computing, where computing resources are put on the same place in order to be shared with customers or clients. In cloud networking, instead of sharing computing resources, the whole network can be shared [14] Cloud Networking is not centralized system, it allows more network management functions into the cloud, therefore network participants could utilize more network resources from the cloud.

Cloud Networking architecture enables visibility and control with reduced costs and complexity of infrastructure services for users and providers (Figure 4).

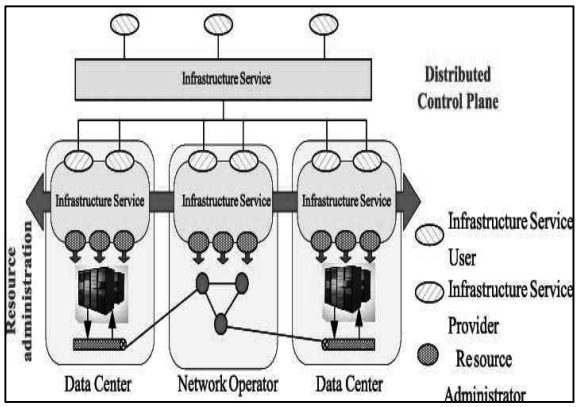

Fig. 4. Cloud Networking architecture [15]

One of the main challenges of this technology is limited support for control functions, such as, the ability to ensure security around the network, performance guarantees, etc. [15] [16]

Using a Cloud networking in cluster-based environment could involve many solutions such as interconnection of virtual servers of universities, companies and research institutes. Simplified process of data and resources sharing among these organizations may result in the evolution of localized industrial clusters into innovative global networks.

5. CONCLUSIONS

Understanding the reasons why SMEs and clusters tend to evolve into global networks, help researchers to look at the further directions of their development. Consideration of ties among network member enables SMEs and other participants to strengths their cooperation and to become competitive on the global market. Creating an innovative environment based on

advanced networking technologies, enable small companies and industrial clusters to become visible and competitive on the global market Some issues such as industry structure, firm strategy, the nature of intra-industry competition and the relationship between knowledge and technology [17] need to be subject of further researches.

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Soft Skills as the Basis for the Development of Professional Competencies

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Abstract

Professional requirements for employees in modern organizations are defined by an increased level of competence, responsibility, commitment and motivation. In such organizational design of knowledge and skills, employees represent the basis of the organization's development. Knowledge Economy and the growing demands of competitors and clients are placed before each and every organization, managing high criteria of sustainability and success. Duration in business requires from each organization proactive approach, technological management changes, risk management, balance between economic growth and ecological sustainability, lifelong learning of each employee, as well as continuous development. The competencies needed for the realization and development of work are all more complex and require much more than professional knowledge and basic knowledge and/or technical skills. Combining professional competencies and development of organizations is only possible with the appropriate development of soft skills of employees at all levels of work processes. Soft skills of employees determine their organizational behavior, skill and efficiency of communication, management conflicts, change management, successful teamwork, increased frustration tolerance, which all affect the quality of the organization's business.

Key words: soft skills, employees, organization

1. INTRODUCTION

Job requirements in modern organizations have increased significantly and refere to professional competencies of employees, related to the performance of work operations alone, but also to personal ones, skills and abilities to turn competence into performance. The speed of creating new knowledge, new products and services has opened up many opportunities for new jobs and new ways of doing business. Organizations that are focused on excellence have recognized the need to develop soft skills of employees such as motivating communication, willingness to work in a team, successful work under pressure and stress, adequate response in conflict situations.

2. SOFT SKILLS OF EMPLOYEES

Changes in business practices contributed to changes in employee requirements, both for individuals and working groups. Employee competencies related to the work itself, such as technical, technological and other, must be supplemented with soft skills. It is even considered that hard skills contribute only 15% of success, and the remaining 85% depends on soft skills [1].

Hard skills relate to technical and administrative, while soft skills are related to human, conceptual and social behavior. Soft skills are different from so-called hard skills, but also they add more value to hard skills. Categories of soft skills include achievements and actions, the

influence and development of others, as well as personal success [2]. Hewitt Sean thinks that employers value soft skills because they are equally good indicators of job performance as a traditional qualification for a job [3].

According to Sean, soft skills are non-technical, intangible, specific skills that determine the individual's strength as a leader, listener and negotiator, or as a mediator of the conflict. Soft skills are the characteristics and abilities of attitude and behavior; these are not knowledge or technical abilities [4]. When talking about soft skills, we think primarily about personality traits, communication skills, stress response, readiness to change, engaging in team performance... It is possible to distinguish the emotional skills that involve recognizing and naming feelings, expressing feelings, assessing intensity of feelings, managing feelings, controlling the drive, reducing stress. There are also the cognitive skills, such as analytics, understanding and interpretation of other people and social events, problem solving and decision making, understanding someone else's view, self-awareness, willingness to work in a team.

3. KNOWLEDGE ABOUT CONFLICT RESOLUTION AND PREVENTION

Attitude towards conflict situations largely determines our business behavior. Conflicts involve competition, tension, misunderstanding, diversity, disagreement, controversy, and strife [5]. Disagreement arises when one party considers that there is a marked divergence of values, needs, interests, opinions or goals. Negative emotions are often the triggers of conflicts and the reasons why conflicts continue.

Competence for conflicts resolution involves an analytic approach to conflict, that demands the most appropriate way that will allow (the prevention or) resolution of conflict situations. Preventing conflicts involves creating a prerequisite that no destructive conflicts arise at all. It implies a number of measures and activities in the sense of practicing the skills of communication, behavior and thinking, as well as solving problems and negotiating. A proactive attitude in conflict means that at least one or all of the parties take a positive and active role in seeking its solution. Of course it is not possible to determine a clear and simple way to resolve the conflict. One of the basic principles is that human beings do not behave mechanically and predictably in accordance with previously defined rules of diving. Conflict, like humans, is multidimensional, complex and predictable only in some cases with rather narrow boundaries. The conflict solution must be adaptive, flexible, sensitive to small and frequent changes and ready for unexpected. The advantages of a constructive conflict in the organization can be seen through many parameters. The most important consequences are that it brings out the problems to light, it increases the understanding of the viewpoint of the other party which enables the change, it leads to better decision-making, increases loyalty to the group, and increases organizational commitment.

Conflicting work roles often contribute to conflicts in organizations. The conflicting work role is present in those situations where an individual must perform mutually incompatible tasks and when they are extorted. Then such a person forcible performs those jobs which does not want to and which considers not to be in his / her jurisdiction. Such jobs do not fit into the image the worker has about his place in the organization and he is considered incompetent for that performance. Fear of conflicts in these working situations only contributes to dissatisfaction and poor performance. Coping with the wrong work role is the communication skill (with oneself and others) that has a significant impact on positive work results.

4. STRESS MANAGEMENT

Different characteristics of individuals and differences between people condition a

different response to stressful situations in work. People have different tolerance to stress, the way of reaction and the consequences, or the effects of stress. Stress is the physiological and psychological reaction of a person to external situations that disturb ones balance. Stressful situations, the so-called stressors, which are part of our everyday life, hurt the person, make the man tense and nervous, which causes numerous physical and psychological changes in the individual.

One precondition for a reduced experience of stress is the increase in tolerance for uncertainty, according to which people are significantly different, and which, beyond doubt, is associated with the experience of stress. People with low tolerance to the uncertainty of change, unclear and undefined situations, ambiguity or equivoque of the role experience more stress then those who have a high tolerance for uncertainty. Raymond Flannery [6] suggests that it is possible to create personal preconditions for stress reducing, or the strategies for its overcoming. It is important to bear in mind:

- Personal control, the belief that the environment can be controlled and that they have specific skills for effective response in specific situations,
- Engagement in the performance of certain tasks that are thoughtfully chosen and have a certain meaning,
- Appropriate diet, regular physical exercises and, during the day, specified time for relaxation,
- Using social support in your own social network.

5. MOTIVATING COMMUNICATION

Ignorance of business communication is one aspect of business failure, and the other, much more serious is the inability to communicate honestly with yourself. Under conditions where an employee is unable to communicate with himself, he / she will not be able to find adequate business communication with others. An assertive style supports individuals who clearly express their opinions and feelings and firmly represent their rights and needs without compromising the rights of others. Assertive communication is born of high self-esteem, people value themselves, their own time, emotional and physical needs and represent their interests while at the same time respecting others. Aggressive communication involves a style in which individuals express their feelings and opinions and represent their needs in a way that violates the rights of others. Aggressive communication highlights the exploitation of others and self-promotion on someone else's account. The style of non-assertive communication is one that encourages others to exploit us [7].

One of the most successful ways of communicating with other people is the motivating communication that produces positive effects for others and for oneself. Motivating communication is:

- Communication with trust
- Communication that includes all relevant segments of business processes
- Readiness to hear and understand the interlocutor / associate
- Empathy in communication
- Respect and high estimation regardless of who is the co-worker
- Continuous positive commitment towards the chosen goal (not ambivalent: time positive-time negative)
- Rewarding even small success
- Impuniting errors, whatever they may be, understanding them as part of the normal processes, draw attention to them, and point out possible removals
- Disciplined to adhere to the agreed goal until the team agrees otherwise, and not change it without notifying other employees about the idea of change

- Offering opportunities for progress, change, activity
- Determination in the idea, emotion and attitude [8].

Motivating communication is one of the tools in human resource management, but also a powerful tool for motivating workers. The results of numerous studies have shown the importance and role of motivating communication.

6. CONCLUSION

The fact that all soft skills are taught and can be adopted at any age and with any educational level provides the possibility of their easier adoption. The reasons why soft skills are not attached to higher importance can be seeked exclusively in ignorance and fear of emotional reactions. The development of professional competences is much faster and complete if it is supported by the development of soft skills. In addition, the development of soft skils is in fact the development of the personality, whose development could improve organizational performances and quality of life. The development of one's own personality would contribute to the possibilities of managing yourself, which is always an improvement in business circumstances.

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Knowledge Transfer in Virtual Teams

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Abstract

Purpose: Having in mind the fact that more and more organizations work internationally, the main purpose of this paper is to analyze and highlights the significance of knowledge transfer in virtual teams.

Design: This paper work provides an overview of existing literature in the field of knowledge transfer and virtual teams. Virtual teams are characterized by use of information and communications technology (ICT), high geographical dispersion, cultural and linguistic diversity, and therefore transfer of knowledge is more difficult in such types of teams.

Findings: This paper provides information about main issues and challenges for knowledge transfer in virtual teams.

Implications for practice: This paper provides useful insights and base for researches in order to expand futher research in a way of better understanding of knowledge transfer in virtual teams.

Keywords: knowledge transfer, virtual teams, collaborative work, communication

1. INTRODUCTION

Teamwork in modern organizations is increasingly recognized as one of the essential components in the effort to develop high-quality workers with good social competences. Growing competition in the global market has been challenged by western companies such as General Motors, IBM, General Electric and others to look for strategies for continuous improvement of quality [1]. Along with the ever-increasing changes in the world, there has been an increasing interest in the performance of work teams [2]. Successful organizations have discovered the potential and contribution of virtual team as way to reduce costs, better quality products and higher productivity. Virtual teams promotes creativity and originality, because the best way to get a good idea is to have a lot of ideas.

Considering that communication and collaboration of virtual teams depends almost exclusively on ICT (information and communications technology), knowledge transfer among team members is difficult because of linguistic and cultural barriers, a difficult coordination and operation due to different time zones and locations, a complicated process of motivation, and the difficulty in strengthening the team spirit.

In spite of everything, work of virtual teams, which is not conditioned by borders, space and time, facilitates and accelerates the process of globalization, since it can gather cheap and high-quality labor, while at the same time relieving many costs that would otherwise occur under traditional working conditions.

2. KNOWLEDGE TRANSFER

Knowledge transfer is a key dimensions of learning organizations. There is no benefit of knowledge, errors and omissions that are only documented in the database or exist in the minds of individuals. To avoid mistakes in the future, they must be visible to all members of the

organization so that they can learn from them and choose the best possible way to avoid them. O'Dell and Grayson [3] cite an example of Chevron, which has cut its costs by more than $ 2 billion in seven years, exclusively through an example and sharing best practices. Similarly, Texas Instruments has increased its capacity for innovation by transferring best practices between 13 plants [3]. Without a sufficiently strong supportive culture of cooperation and trust, transfer of knowledge will not lead to the desired results [4]. A high level of trust is a necessary condition for cooperation between individuals and groups. Certain practices in the organization can foster trust among employees. When decisions are made openly and when information is widely available and accessible to each member of the organization, the frequency of communication increases as well as willingness to share information.

As Goh [4] further notes, the culture of cooperation alone is not sufficient for a successful transfer of knowledge. Culture must encourage employees to search for problems, solve them and consider them as a challenge and opportunity to improve the quality of products or services.

3. VIRTUAL TEAMS

The incentive for the formation of virtual teams is an increasingly dynamic environment, the complexity of tasks, globalization and decentralized expertise and knowledge. When specialists from different fields associate, the effect of synergy is achieved, so certain task is solved in the best way.

Virtual teams are groups of people who primarily cooperate through ICT in order to connect physically distant members, with the intent to achieve common goals. Unlike classic teams, members of virtual teams can communicate face-to-face only occasionally and if necessary. The observed business connection has the following basic characteristic: the possibility of engaging experts regardless of their geographical distance.

Virtual teams include participants from different culture settings and organizations. They often work on non routine task. Virtual teams provide lower costs, flexibility and better resource using, in order to to deal with a dynamic environment in an adequate way [5,6].

Virtual teams ensure a lot of advantages, but also include some costs. Figure 1 summarizes the most important opportunities and liabilities.

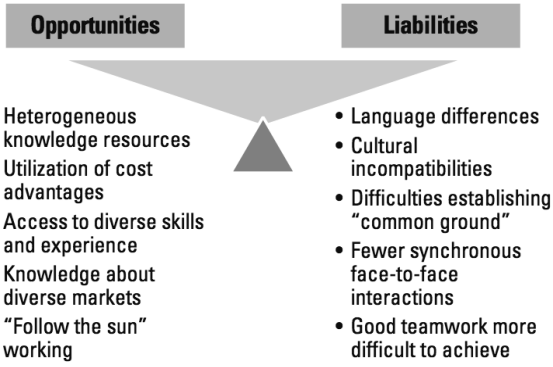

Fig. 1. Characteristics of virtual teams [7]

4. KNOWLEDGE TRANSFER IN VIRTUAL TEAMS

Considering the existing literature of knowledge management, knowledge transfer and virtual teams, Sarker et al. [8] identified four Cs (communication, capability, credibility and culture), combined with individuals who transfer significant amounts of knowledge to remote members.

Mutual trust is a prerequisite for the knowledge transfer. Numerous studies show that mutual trust positively influences the knowledge exchange [9,10]. Trust entails mutual concern, reliability and competence. If there is trust among the members of the virtual team, the sharing of information will be freer, the coordination of knowledge among team members is more effective, and the quality of shared knowledge and information is much greater. Also, organizational context and communication among the members of virtual teams is essential for knowledge transfer. Virtual teams support flatter organization structure. Nothing is more substantial for successfully virtual team performance than

communication, because communication over distance can make difficult transfer of knowledge. Leaders of virtual teams must ensure that team members get proof of effective communication, enhance a sence of belonging and build supportive environment. Some studies indicate that a geographical dispersion has a negative impact on more deeply tacit knowledge transfer in virtual teams [11]. Wong and Burton [12] finds that the success of knowledge transfer in virtual teams depends on context (dispersion), composition (organizational and cultural heterogeneity) and structure (model of relationships among members in virtual teams).

Futher, Bosch-Sijtsema and Rispens [13] developed a theoretical framework and social network approach in order to stimulate communication and knowledge transfer in different knowledge field. They realized that by using social network approach and assessing and reusing the data with members of virtual team, the communication structure within distributed team became more obvious. In their case study, two types of knowledge transfer were included: organizational knowledge transfer, related to way of virtual team organization and task knowledge transfer, which refers to way of problem solving. They found that the friendship, good relationships and trust (social context) made knowledge transfer easier.

5. RESULTS AND ACHIEVEMENTS

The main purpose of this paper was to provide some insights, factors and major challenges which affect to knowledge transfer in virtual teams. This study has implications for practitioners and future testable hypotheses development for the academia in the field of knowledge transfer and virtual teams. Greatest challenges in working processes of virtual teams are in maintaining good relationship among team members, so cultural issues and differences must be taken into consideration. Communication is one of the most important things in virtual team. It begins with selection of good communication tools that will be used by team members and also the choice of appropriate technology.

6. CONCLUSIONS

In today's business environment characterized by competitiveness, fostering economic development, more and more short product life cycles, organizations must to found virtual teams, in order to deal with the fast changing ambience. Economics, standardization of services and efficiency are criteria of modern business and functioning of which impose the necessity of forming virtual teams as a part of inevitable globalization. Because of this facts, virtual teams have attracted increasing interest among researchers and practitioners.

Some research proposes that virtual team members can't believe that their behaviour in traditional teams will be successful in virtual environments. For knowledge transfer, virtual collaboration and building trust among team members, new improved type of communication competencies is needed.

We should be aware of the fact that in spite of many advantages that virtual teams offer, they naturally limit the effectiveness of knowledge flows, because of time and spatial boundaries. The introduction of information systems can increase efficiency and productivity, eliminate unnecessary duplication of data collection, increace the quality and efficiency of work.

Virtual teams are a great challenge that requires a lot of tasks to be successfully guided by managers. To be successful virtual teams must be well structured, guided and supported. Mutual trust of members must be at a high level, because social relations are important for the success of such teams and knowledge transfer.

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The Role of Trust in Knowledge Sharing Among Employees

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Abstract

Trust among the employees is a significant prerequisite for establishing organizational relationships in which individual knowledge is shared and thus organizational knowledge is increased. The process of trust is created as a result of the realized expectations of an individual in relation to another individual or group in the achievement of the natural and moral social order, as well as the expectations of competence and correctness in business communications. This paper analyzes the role of trust in knowledge sharing process in organizations, as well as key factors that link these two processes. The matter of trust among employees became more significant lately, since great changes emerged in a way of performing certain work processes. On the other hand, the highly specialized jobs and knowledge which it requires, contribute to the conditions in which the transfer and sharing of knowledge is one of the most important factors for the development of the organization.

Key words: trust, knowledge sharing, employees, organization

1. INTRODUCTION

Communication among employees in organizations is focused on the free flow of ideas and information, thus creating that specific synergy, which leads to new solutions and creative work. Modern business trends have contributed to strengthening the coherence between the organization and the individual, at the same time, reinforcing the impact on the way they are managed.

2. TRUST IN BUSINESS COMMUNICATION

Trust is a complex psychological and sociological category, that refers to multi-layered orientation towards other people. The essence of trust is knowledge and experience, as well as the belief that the established trust will be maintained. The status of trust can be influenced by membership in a particular group, the role that an individual has in the organization, various rules that secure trust, as well as psychological categories such as the power of emotion or motivation.

Trust is defined as the willingness of one party to accept the actions of the other party on the basis of the expectation that the other party will carry out a particular action important to ones, without the possibility of controlling its work [1]. According to Zaheer and his associates, trust is an individual tendency towards belief in something that you have determined [2]. Trust implies reliability on both sides in communication, faith in good intentions and ability of the other and uncertainty in relationships [3]. The tendency to trust is often seen as a personality trait, but it can also be influenced and shaped in a culture that is dominant in one society [4].

Multidimensionality of trust in organizational behavior involves consideration of several dimensions of trust: trust in one's ability, trust in one's intentions, contractual

trust, voluntary trust, interpersonal trust and institutional trust. People have a need to trust because of the fear of punishment if they do not do what is expected of them, in order to realize their own interests, to demonstrate empathy, identification and friendship; or simply because they want to give their trust. The reasons for trust building, as well as the basics on which trust is based are different. Some scholars believe that there are three different dimensions of trust - cognitive, affective and emotional dimension, and also the dimension of behavior.

The cognitive dimension implies that trust is built after learning about the personal and institutional characteristics of another person, group, institution or system. The affective dimension involves an emotional connection and investment in the relationship of trust between the actors, and the behavioral dimension of trust involves taking the risk during the action. Luis and Weigert argued that trust in everyday life is a mixture of feelings and rational thinking, which is not clearly differentiated and it's very difficult to separate them. Most often, in the literature, we actually find the distinction between emotional trust and cognitive trust, and both of it have been studied in special research. Emotional trust is the result of specific behaviors and perceptions of an individual. Cognitive trust is based on concrete relationships, such as common experiences that contribute to reducing insecurity in interpersonal relationships [5], and both types of trust play a role in fostering the exchange of information within the organization [6].

There is also difference between the initial trust, which occurs early in communications and is based on affective, emotional and cognitive signs, and a more lasting trust, based on real experience between people at a given time. As shown, concept of trust has been examined through various aspects, of which, probably the best known is the one from authors Lewicki and Bunker, who distinguish three levels of trust: trust based on calculation, knowledge-based trust and trust based on identification [7]. On the other hand, there is a routine trust [8], based on a combination of rational foundation and psychologically experienced cause. Benefits for all participants in trust-based communication are reflected through cohesion in joint activities, reduction of potential opportunistic activities, reduction in the use of formal contacts, greater reliability in creating outcomes, predictability and openness in communication, and increasing effectiveness [9]. According to Mishra, there are four dimensions of organizational trust: competence, openness and honesty, care for employees and reliability. Recent studies of Shakley-Zalabak, Elis and Vineyards revealed another factor that is of equal importance for consideration, as well as the four listed - it is identification [10].

High level trust organizations tend to create products and services with lower costs, as employees are more motivated, they take risks, create innovations, they accept more easily the vision, mission and values of the organization.

3. KNOWLEDGE SHARING IN ORGANIZATIONS

Modern business has imposed requirements to employees on more open and complex business communication. In such conditions, the problem of sharing and transferring knowledge has been highlighted as one of the key factors for successful business, especially in service activities and organizations dealing with information technology. Knowledge transfer, seen as an organizational process, plays a key role in creating new business opportunities and generating new ideas [11]. The traditional concept of knowledge management was essentially based on information systems that would store knowledge in the most adequate way, making it readily accessible. The new knowledge management model is based primarily on employee engagement and on the mutual

transfer of knowledge, that is the basis for development [12].

The basic principles in knowledge sharing are: reciprocity that implies the equal benefit of sharing knowledge both for the organization and for the individual, then recognizing that there is a shared ownership of knowledge between the individual, the organization and the wider community, as well as the application and use of knowledge. The key question that arises is why employees would share knowledge if knowledge is their personal competitive advantage? Under what circumstances does knowledge sharing contribute to greater success?

One of the most important problems in modern organizations is how to translate ones knowledge into the understandable and practically applicable knowledge of other people and organizations as a whole. Under conditions where knowledge is effectively transmitted through an organization, the most important result is improving employee performance and improving organizational performance [13]. According to researchers, in organizations where there are no adequate knowledge transfer mechanisms, there are a number of problems that are always reflected in the ultimate management and business of the organization.

4. THE CONNECTION OF TRUST AND KNOWLEDGE SHARING

The basic prerequisite for transferring knowledge is communication among employees, and this communication would also certainly entail trust among the participants. Linking trust and knowledge sharing can be viewed through two approaches: one approache refers to research that consider that organizational trust directly influence the creation of knowledge, and the other one relates to opinions that reveal indirect mechanisms of influence of trust on knowledge sharing.

It is believed that organizational trust is particularly important for creating new knowledge and innovations. Organizational learning is a process of acquiring new knowledge and adapting to changes, so it is often emphasized that organizational learning is a special way of adaptation the organization to external influences and changes. The greatest part of the overall effect of organizational trust in knowledge creation arises from the direct effect of trust, as well as from the indirect impact through the processes of knowledge sharing. Creating a new organizational knowledge requires the confidence that must be contained in the organizational culture [14].

The complexity of the relationship between these two phenomena has been shown by numerous studies. For example, the study of Chowdhury provides an empirical overview of the impact of interpersonal trust on a complex knowledge sharing, using dyads within the team, as a unit of trust analysis and knowledge sharing between two people working in the team. The research has shown that even two variables (gender diversity and team size) control the level of trust within the dyad and it significantly predicts the scope of complex knowledge sharing. A practical conclusion drawn from this extensive research shows that trust must be developed between each member of the team and not only among certain individuals [15]. Different research on relationships between trust and knowledge sharing were based on the study of the effects of alternative types of trust on a general knowledge transfer [16]. McAllister develops and empirically examines the difference between the two types of trust: influence based trust, build on mutual concern between employees and trust based on knowledge, build on the reliability and competence of associates. Also, he questions the effects of how do employees connect the impact on trust and willingness of to share and use their knowledge [17]. Research has shown that influence based trust significantly affects

readiness to share individual invisible knowledge, while trust based on cognitive aspects (trust based on knowledge) has a greater role in readiness to use it.

The research of Swift and Hwang aimed at showing differences in the level of knowledge sharing between associates in conditions of high and low trust level, on cognitive and affective aspects of trust, as well as implicit and explicit knowledge. The results revealed significant differences in levels of knowledge sharing in high and low trust frames, with the effect greater for trust based on impact and implicit knowledge [18]. The strategic importance of sharing knowledge and its relationship with organizational and management mechanisms has also been explored through the consideration of personal characteristics that contribute to the exchange of knowledge through interpersonal trust, which points to new, non-organizational aspects that significantly influence the sharing of knowledge in organizations [19]. One of the questiones raised in knowledge management refers to the establishment of policies and procedures in the knowledge sharing process, as well as clear knowledge management strategies based on the trust of employees and stakeholders in interaction [20].

5. CONCLUSION

Knowledge sharing process is one of the most important prerequisites for the growth of both organizations and employees. Factors that condition it are primarily the adoption of new knowledge of employees in organizations, but also the communication in which trust among employees contributes to the quality of knowledge sharing and its consequences for the organization, first indirectly, through employee relations, and then directly through economic performance. There is a large number of scientific papers showing the connection of trust and knowledge sharing, which require more space for analysis. The development of business relations will lead to new results and future research will certainly show other dimensions of these connections.

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The Differences between IT and Non-IT Companies with Respect to Internal Additional Compensations

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Abstract

The paper aims to present variables that can highlight general differences between IT (information technologies) and non-IT companies with respect to overall internal additional compensation policies. IT sector has experienced a significant development over the last 10 years and was manifested as the most efficient in the economies all over the world, including developing markets. It is thus interesting to present potential variables that can help in realizing whether there are some general differences present between IT and non-IT firms in this particular domain of personnel management. Therefore, this paper presents potential variables to be observed in order to determine differences of compensation systems with respect to internal additional compensations. Implementation of well-defined internal additional compensations policy, i.e. additional material and non-material compensations policy, could equip a company with higher employees satisfaction, better motivation and, consequently, better business results which is the main goal of every enterprise. The companies should make adjustments of their compensation systems continuously and in accordance with the specific needs, increase the effectiveness of compensation incentives and ultimately realize the goal of attracting, retaining and stimulating employees

Keywords: IT and non-IT companies, additional compensations, compensations timing

1. INTRODUCTION

Small and medium-sized enterprises (SMEs) take significant roles in many industry branches. Therefore, SMEs as the driving force of economic growth have an important effect on the economic activity. The basic characteristic of small and medium-sized enterprises (SMEs) is flexibility, which means that they experience fast adaptation to everyday market changes. SMEs are the most important actors for developing innovation, competitiveness, entrepreneurship and the establishment of an effective innovation system for both advanced and developing countries.

Recent years showcase that it has been important for SMEs to make well-designed compensation policy and more focus on additional compensations in order to keep their employees.

„Nowadays, when market environment is more and more globalized, brand value building and managing is a significant challenge for managers" [1]. Therefore, well-designed compensation policy and employees satisfactions are important factor in the development of business results (e.g. revenues) in SMEs. The process of improving competencies of employees in SMEs affects the motivation, satisfaction and success at the individual level and the productivity and the best business results at the organizational level.

2. SME AND COMPENSATIONS

The SME plays an important part in modern economy, proving to be the most attractive innovative system and good employement posture.

Peter Drucker said that small enterprises represent the main factor of economic development. „Those small businesses contribute intensely to achieving the fundamental goals to any national economy, becoming the backbone of social-economical progress" [2].

When we speak about their definition, SMEs are usualy defined by the number of employees. SMEs have a range of 0-250 employees. [3]

Small businesses' size standards vary by the industry within which the business operates: construction, manufacturing, mining, transportation, wholesale trade, retail trade, and services. [4]

In many developed and developing countries, SMEs form a large part of private sector. „Small and medium size firms face larger growth constraints and have less access to formal sources of external finance, potentially explaining the lack of SMEs contribution to growth" [5].

2.1. Compensations

„Compensation refers to all forms of financial returns and benefits that an employee receives as a part of an employment contract" [6].

A completly understanding of policy of compensations is very important to developing a viable theory of the firm, since these incentives determine to a large extent how individuals inside an organization behave.

The higher performance requires greater effort or that it is in some other way associated with disutility on the part of workers that economic models of compensation generally assume. The existence of reward systems that structure compensation so that a worker's expected utility increases with observed productivity. [7]

„Compensation is output and the benefit that employee receive in the form of pay, wages and also same rewards like monetary exchange for the employee's to increases the performance" [8].

The most common division of compensations is into basic (wages/salaries) and additional. [9], [10]. The goal of basic compensations is to ensure material position of employees and to improve it at the same time, while additional compensations are more of ad hoc nature and can be further divided into material and non-material additional compensations. Whether they take a form of additional material compensations (bonuses - usually in cash, benefits, stocks and options, etc.) or additional non-material compensations (e.g. professional training, development programs, etc.), additional compensations are considered as operational costs that top-up fixed personnel costs.

There are two forms of compensations for employees: basic and additional.

- Basic compensation (salaries / wages) are made up of different forms of motivation which are directed to ensure and improve the material position of employees and are considered as material compensation for the work.
- Additional compensation consists of various types of benefits and long term incentives and it can be divided into material and non-material.
- Additional material compensation - an individual incentive in the form of cash or other equivalent that an employee receives.
- Additional non-material compensation - the one that contributes to raising the skills and knowledge of employees and where they do not receive cash or other equivalent from their employer.

Support from enterprises, whether in the form of an additional material compensation or non-material compensation for them represents a financial cost. It is necessary to determine how much of the total cost is allocated to salary/wages and how much to the additional compensation.

2.2. IT and non-IT SMEs

IT sector has experienced a significant development over the last 10 years and was manifested as the most efficient in the economies all over the world, including developing markets. Nowadays most of the big international companies found that virtual communications are very useful. They can use it to hold a virtual conference between companies in different countries at any time and any day.

"The importance of existence of a strong and dynamic high technology companies sector in the current world economy is enormous as it largely influences the potential for global competitiveness of individual nations or regions. In the developed, post-industrial economies the high technology companies sector is commonly regarded as the area with the largest use of and dependence on the so called special means of production – knowledge and human resources" [11]. In this article, the author concluded that IT companies invest in knowledge and education of employees, which is one of the most important segments of additional non-material compensations. [11]

Non-IT SMEs have limited financial resources which represents a huge problem with respect to additional non-material compensations.

We can conclude, based on some research, the existence of differences between IT and non-IT companies with respect to internal additional compensations, where high-tech firms generally pay higher levels of total compensation than low-tech firms and grant larger amounts of additional compensation. [12]

The first challenge in providing employee benefits (EB) is an issue of additional costs. SMEs' biggest developmental challenges normally concerned with limited size especially salient with regard to innovation and finance. [13]

One study in India concluded that a significant difference in the mean agreeability scores on financial and non-financial performances of SMEs exists when it comes to examining relationship and impact of compensation and rewards practices on organizational performance. [14]

Well-performing small firms in developed economies use more of material (e.g. cash) incentive compensation at every level in the organization. [15]

3. POTENTIAL VARIABLES TO BE OBSERVED

The main goal of every successful enterprise is implementation of well-defined internal additional compensations policy, i.e. additional material and non-material compensations policy, that could equip a company with higher employees satisfaction, better motivation and, consequently, better individual and in the end business results. The companies should make increase the effectiveness of compensation incentives, adjustments of their compensation systems continuously and in accordance with the specific needs, and ultimately realize the goal of stimulating, attracting, and retaining employees.

When we have focused on IT and non-IT companies, it should be further researched the differences between IT and non-IT companies with respect to internal additional compensations.

In addition to many variables that can be observed to determine the difference between IT and non-IT companies with respect to internal additional compensations, we can focus on several variables that can support owners and managers in understanding the best possible relation between investment in more compensation and potential business outcome on organizational level. Such variables can be used for further amplify the relationship between

additional compensations policy and revenues. Herewith we present four variables and they are given in Figure 1. These include the following:

- Industry sector to which SMEs belong (differentiation between IT and non-IT). The IT sector has developed significantly over the last 10 years and proved a great success in the economy around the world. It would be interesting to compare it with other sectors SMEs and show results.
- Employee category receiving an additional compensation (differentiation between management and operations). It would be interesting to determine and compare whether there are differences between employee levels, i.e. to present how and in which way management and operations levels are compensated.
- Interval (percentage) top-up on basic compensations costs (i.e. percentage of total fixed costs for staff). Likert scale which represents different intervals of percentage of total fixed costs for staff could be used.
- Timing of compensation (number of quarters in a year when additional compensation is performed). Usually, compensations are made quarterly, biannually or once per year. It would be interesting to divide compensations in four quarters (I, II, III and IV) and enable selection of multiple quarters at the same time.

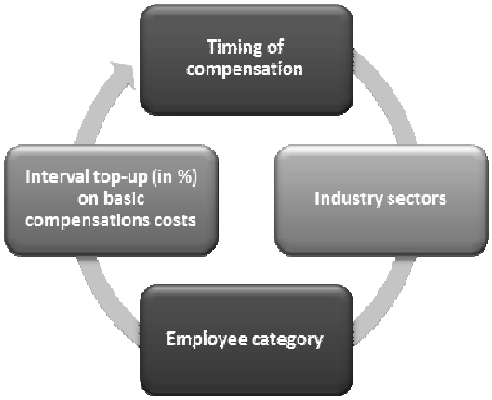

Fig. 1. Compensations-revenues dependence observed variables

Observed variables and their interaction can help SME owners and managers and give a framework pattern useful for day-to-day business operations when deciding on additional compensations realization. Therefore, defined compensation policy will effectively respond to these challenges and ensure that the enterprise offers a flexible response to every change in the frequently turbulent environment.

4. CONCLUSIONS

The commercialization of IT is widespread throughout the world, so that IT can create new business opportunities. IT also enhances the competitiveness by integrating the supply chain partners with the inter-organizational functions. [16]. Across many industry branches and within numerous SMEs additional compensations policy has become widely applicable and it strives to provide added-value to employees. At the same time, it should have a clear cost-benefit analysis for entrepreneurs and owners and managers and this paper contributes in this respect. Therefore, the expected contribution of this paper can help professional business owners and managers are given additional compensations insight useful for their day-to-day business operations. This might help them to understand better how certain observed variables influence the overall revenues growth, by exploring the cross-sectoral differences.

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Examining the Impact of Lean Tools on Time-Based Efficiency and Inventory Performance in the Conditions of Transitional Economy

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Abstract

The aim of this study was to examine the nature of relationships between Lean tools and organizational performances. Specifically, the impact of Lean tools implementation on time-based efficiency and inventory performances was studied, with the particular interest on how afore-mentioned research constructs are coupled in the conditions of transitional economy. For the research purposes, a questionnaire as a research instrument was distributed to 217 organizations. The sample was consisted of respondents from various industry sectors. The results show that not all Lean tools have a positive effect on organizational performances. In particular, the effects of 5S and One-peace flow are the only tools that produce statistically significant impact on organizational performance (i.e. time-based efficiency). Bearing in mind that studies from developed economies are, in most cases, proponents of positive impact, the results of this study are contradictory in nature. Such shortcomings might be due to the unfavourable climate and transitional conditions, in which research organizations tend to manage their everyday business.

Keywords: lean tools and practices, time-based efficiency, inventory, organizational performance

1. INTRODUCTION

The enterprise environment is highly changing and uncertain due to many factors of which globalisation, shorter product lifecycle, increased product variety, etc.; therefore the manufacturing systems have to be agile or flexible to face such changing environment while keeping high performance [1]. To achieve dramatic result in cost, quality and time, best strategies need to be applied to enhance the process performance [2]. Lean manufacturing has been widely used to increase operational excellence and performance in manufacturing systems [3].

The Lean manufacturing practices enable companies to gain increasingly high level of efficiency and productivity, with improved speed of delivery, minimum stock levels and optimum quality [4].

Lean manufacturing should be considered not just a set of tools and techniques, even that involves a large set of them, but a working philosophy that adopted by the company can make significant improvements in terms of their operational performance [5].

The relationship of Lean tools and time-based efficiency and inventory have been examined in this paper. In accordance with the literature, the included Lean tools in this paper are: Kanban, Continuous Flow manufacturing, Visual Management (VM), Statistical Process Control (SPC), Total Productivity Maintenance

(TPM), 5S Housekeeping, Value Stream Mapping (VSM), Poka-Yoke, Cellular manufacturing (CM), Standardize Work, Single-Minute Exchange of Dies (SMED) and One-piece Flow.

The effect of aforementioned dimensions on time-based efficiency and inventory has been examined using multiple regression analysis.

The findings reveal that dimensions 5S and One-piece flow show positive effect on time-based efficiency.

Even it is found, in most cases, that the implementation of Lean tools provides a very useful basis for the improvement of organizational performance in developing countries, it seems that some of the key dimensions do not affect organizational performances in an unfavourable environment as expected.

2. METHODS AND MATERIALS USED FOR RESEARCH

2.1. Measures, questionnaire development, distribution and data gathering

Developing of the questionnaire was in accordance with Saraph, et al. (1989) using a five-points Likert scale to obtain subjective assessments by the respondents (Nunnally, 1994).

516 (72.98%), of total 707 organizations which were contacted, have taken part in this research.

To each organization an electronic version of the questionnaire was distributed and 217 (30.69%), of total 516 organizations which have participated, filled out the questionnaire, after a three-month period.

The research instrument contained:

- 12 dimensions of Lean concepts,
- 5 items grouped into dependent variable - time-based efficiency and
- 5 items grouped into dependent variable - inventory.

2.2. Dimensions and hypotheses

Following, brief explanations of each independent dimension in the model are given and hypotheses are presented.

Kanban: By providing more control at the operational level and reducing the risk of material shortage Kanban is viewed as an efficient system for the improvement of the process flow between suppliers, manufacturing warehouse and the assembly line [6]. Implementation of Kanban supports decrease of WIP inventory and reduction of non-value added time. Based on these facts, the following assumption was set:

H1: Kanban has a positive effect on time efficiency and inventory

Layout - Continuous flow manufacturing: The results from different studies show that continuous flow is crucial for Lean manufacturing implementation (Zahraee 2016). Continuous flow manufacturing should provide an effective material flow path with no backtracking, congestion, undesirable intersections with other paths, and bypassing [7] where the efficiency of a layout is typically measured in terms of material handling (transportation) cost [8]. The optimization of the layout of a plant can improve productivity, safety and quality of products. The layout optimization allows reducing materials handling and storage. [7] The aforementioned statements imply following assumptions:

H2: Layout - continuous flow manufacturing has a positive effect on time efficiency and inventory

Visual management (VM): As a response to complex and heavily textual work instructions, which rarely assist the overall operational performance [9], adoption of visual management (VM) has been gaining on importance. VM can be explained as economically affordable and effective sensory information tools integrated into the workplace in order to increase the

information availability and transparency [9], (Tezel et al. 2016). VM has demonstrated practical implications such as reduction in process and motion wastes and delivery delays [10], [11] and better utilization of resources. In accordance to the previously said, the following assumption was set:

H3: VM has a positive effect on time efficiency and inventory

Statistical process control (SPC): Unstable and uncontrollable process results in production of nonconforming product, which affect the overall production performance. To overcome this, the implementation of SPC is being proposed, in order to achieve continuous improvement of the production capabilities [12]. The purpose of SPC implementation is to improve the product quality, improve productivity, reduce wastes, reduce defects and improve customer values [13] and to identify the significant defect and reduce the process variations to consistently produce more conforming products, consequently contributing to the cost improved manufacturing process [14]. This implies:

H4: SPC has a positive effect on time efficiency and inventory

Total Productivity Maintenance (TPM): The TPM technique helps the companies to fare well in terms of setup time and cost reduction [14]. Used as a tool to prevent failures and delays in the manufacturing process TPM is led by the implication that all the facilities and machines are maintained in controlled working conditions. Related to this, the aim is to maximize overall equipment effectiveness (OEE), implying that facilities are at maximum utilization level, without malfunctions and scrapped products or semi-final products, eliminating the possibilities for additional costs. Accordingly, the assumption is:

H5: TPM has a positive effect on time efficiency and inventory

5S Housekeeping: The purpose of the 5S application is to discard unnecessary tools and designate different types of tools for easy access, enhancing productivity of the shop [14]. Moreover, workplace standardization increases space utilization, decreases redundant workers movements, time and material, improves productivity and safety and helps decrease of inventory. This implies:

H6: 5S has a positive effect on time efficiency and inventory

Value Stream Mapping (VSM): VSM is viewed as a basis of the Lean strategy on the most important measures of operational performance, i.e. speed, quality, flexibility and cost. Studies show that application of VSM facilitates identification of different improvement possibilities necessary for accomplishment of results, such as WIP reduction, reduction of final products inventory and decrease of processing time [14]. On this basis, the following assumption was set:

H7: VSM has a positive effect on time efficiency and inventory

Root cause analysis and elimination (RCA): Root cause analysis presents a problem solving method used to identify the root causes of problems, acting as a pro-active tool of continuous improvement [15]. A case study in a manufacturing company [15] marked that reducing process variations results in a higher quality product and financial savings from reducing scrap, defects, labor costs, etc. Accordingly, we assume the following:

H8: Root cause analysis and elimination has a positive effect on time efficiency and inventory

Cellular manufacturing (CM): CM indicates that the entire process is systemized for a particular product or related products into a set or cell that includes all the necessary equipment, machines and operators (Zahraee 2016a). Among many techniques in Lean manufacturing, cellular manufacturing is associated mainly with the inventory and the lead times [15]. Existing literature reveals that the main motives for implementation of CM are

minimization of the throughput time, improvement of the product quality, reduction of the WIP levels and stocks which furthermore decrease the cost. On this basis, the following assumption was set:

H9: CM has a positive effect on time efficiency and inventory

Standardize work: It is highly recommended to create work instructions for standard operation procedures (since they make it certain that the processes are consistent, timely and repeatable), as a result high overall performance and enhance human effectiveness in production processes would be ensured [15]. Thus, the assumption is:

H10: Standardize work has a positive effect on time efficiency and inventory

SMED - change-over times: The SMED technique represents Lean tool intended to reduce waste in the production system and to standardize machine changeover times [16], [17]. Although, the main goal of SMED is to reduce machine changeover time, with the standardization of the changeover necessary resources are planned and quantified, enabling inclusion of certain improvements to reduce necessary resources (Lozano et al. 2016). We assume the following:

H11: SMED has a positive effect on time efficiency and inventory

One-piece flow: One-piece flow is Lean tools mostly used for reduction of inventory (Belekoukias et al. 2014). From an economic point of view, short throughput times, high schedule reliability, high utilization and low work in progress inventory are very important logistic objectives [18]. The following assumption was set:

H12: One-piece flow has a positive effect on time efficiency and inventory

3. RESULTS AND ACHIEVEMENTS

3.1. Regression analysis and results

Focus area of this research model is impact of Lean tools on time-based efficiency and inventory performance. Using SPSS software (V2.3), multiple linear regression is performed to examine the impact of Lean tools on dependent variables (time-based efficiency and inventory).

Correlation coefficients between these dimensions should indicate the level of Lean tools influence on time reduction and inventory performance improvement, which are a desired outcome.

Delivered R^2 (0.481), i.e. R^2 (0.476) implies adequate relationship between Lean tools (5S and One-piece Flow) and time-based efficiency and inventory, where Lean constructs depicts 48% of variation in time-based efficiency performance, i.e. 47% in inventory (Figure 1).

According to the obtained results, hypotheses *H(11)* and *H(23)* are not being rejected. One-piece Flow has the greatest positive influence on time-based efficiency; it obtains significance path value with 0.007. Significance path coefficient with 0.036 has 5S concept, as the last, but not least, tool which has positive impact on time-based efficiency (Figure 1).

On the other hand, Lean tools that showing no significant impact (significance path coefficient > 0.05) on time-based efficiency are: Kanban, Continuous Flow, Visual Management, SPC, TPM, VSM, Poka-Yoke, Autonomous Work Units, Standardization and SMED. Considering this, assumptions *H(1), H(3), H(5), H(7), H(9), H(13), H(15), H(17), H(19), H(21)* are being rejected.

Nevertheless, all hypotheses that describe impact of Lean tools on inventory are being rejected.

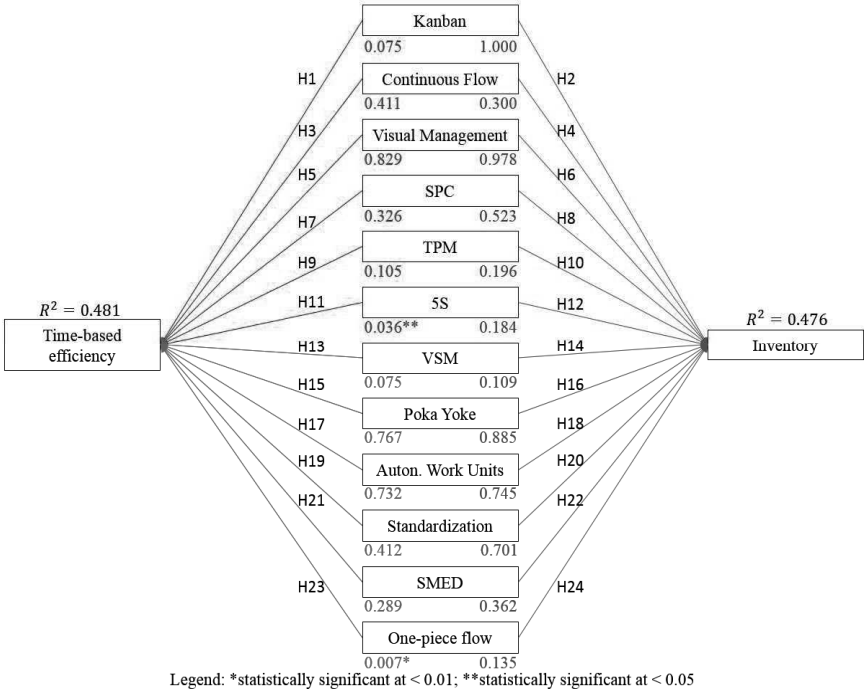

Fig. 1. Research model

3.2. Correlation analysis

To investigate existence of correlation between manifest variables which built dependent variables (time-based efficiency and inventory), correlation analysis is performed using SPSS software (V2.3).

Manifest variables which built time-based efficiency are:

a) the average preparation time for a new product is constantly decreasing,
b) the average lead time is constantly decreasing,
c) the average tact time is constantly decreasing,
d) the average unavailability of equipment is constantly decreasing,
e) the average time for development of new product is constantly decreasing.

Manifest variables which built inventory are:

f) profit is constantly increasing,
g) annual turnover of inventories is constantly increasing,
h) ratio of inventory value and total income is constantly decreasing,
i) ratio of value of incomplete production and total sales is constantly decreasing,
j) ratio of finished products stock value and raw materials stock is constantly decreasing.

Correlation coefficients between these dimensions indicate the existence of a significantly high degree. It is a positive sign of all correlation coefficients, which could mean that with the growth / fall of one variable, the other variable will increase / decrease (table 1).

Shown in the table 1, the highest degree of correlation coefficient is between manifest variables ***b*** (the average lead time is constantly decreasing) and ***c*** (the average tact time is constantly decreasing) with ***r = 0.811***, but the lowest degree is between manifest variables ***e*** (the average time for development of new product is constantly decreasing) and ***j*** (ratio of finished products stock value and raw materials stock is constantly decreasing) with ***r = 0.257***.

3.3. Variance Inflation Factor (VIF)

In order to identify the presence of multicollinearities between the independent variables in regression analysis, the most commonly used is the Variance Inflation Factor (VIF) and Tolerance Test.

Table 1. Correlation analysis between *manifest variables - Pearson Correlation*

Manifest variables	a	b	c	d	e	f	g	h	i	j
Mean	3.70	3.67	3.29	3.63	3.45	3.56	3.23	3.19	3.55	3.20
StDev	1.136	1.180	1.231	1.095	1.162	1.148	1.073	1.000	0.996	1.038
a	1	.767**	.699**	.674**	.545**	.548**	.474**	.390**	.595**	.534**
b		1	.811**	.641**	.490**	.499**	.520**	.533**	.631**	.541**
c			1	.636**	.549**	.392**	.438**	.480**	.538**	.479**
d				1	.581**	.495**	.451**	.410**	.513**	.506**
e					1	.418**	.371**	.309**	.405**	.257*
f						1	.567**	.363**	.500**	.410**
g							1	.444**	.485**	.367**
h								1	.474**	.779**
i									1	.706**
j										1

*** Statistically significant at the 0.01 level (2-tailed),* Statistically significant at the 0.05 level (2-tailed)*

Multicollinearity is when there is correlation between predictors (i.e. independent variables) in a model; it's presence can adversely affect regression results. The numerical value for VIF means what percentage the variance is inflated for each coefficient. VIFs are calculated by taking a predictor and regressing it against every other predictor in the model.

A rule of thumb for interpreting the variance inflation factor:

- ≤ 1 - not correlated,
- $1 \leq x \leq 5$ - moderately correlated,
- > 5 - highly correlated.

Last, but not the least, tolerance above 0.1 indicates presence of multicollinearity. VIF and Tolerance tests were performed and results are shown in the table 2.

Table 2. VIF and Tolerance test (1/VIF)

Independent variables	VIF	1/VIF
Kanban	1.808	0,55
Continuous flow	1.481	0,67
Visual Management	2.515	0,40
SPC	2.719	0.37
TPM	2.802	0.36
5S	1.702	0.59
VSM	2.065	0,48
Auton. Work Units	1.300	0.77
Standardization	1.986	0.50
SMED	1.891	0.53
One-piece Flow	1.777	0.56

Both tests show that there is no presence of multicollinearity between independent variables.

4. CONCLUSIONS

This paper is a contribution to the organizational performance. Its subject is the impact of Lean tools on organizational performances such as time-based efficiency and inventory in transition conditions. The results confirm significant relationships between some Lean dimensions (One-piece Flow and 5S) and time-based efficiency.

It is assumed that the main causes of unexpected results are insufficient awareness of employees about benefits of applying Lean tools and insufficient top management commitment in strategic planning of introduction of Lean in varied contexts.

Based on these results, it can be argued that the benefits of applying Lean tools in transition conditions are arguable and probably predetermined by various factors, such as production characteristics, size of the plant, geographic location and organizational structure.

Nevertheless, according to the experiences of some authors, some organizations in Serbia apply Lean tools. Success of application of Lean tools in these organizations represent good business practice with a healthy core of systematic improvement of performance and organizational culture.

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Organizational Culture in e-Learning: A Key for Business Success

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Abstract

This paper discusses the theoretical and practical nature and quality of relations between organizational culture and e-learning processes within organizations. In multinational businesses with a global presence, work groups often span between distant offices, co-working space and even private homes and hotels, commonly known as virtual teams. Technology allows companies to use the best global talent and drastically reduce their costs, but this available technology can also be used to deliver educational content through internet or intranet networks and offer flexible learning solutions to employees who already manage their work flexibly. The main purpose of this paper is to stress the importance of e-learning within organizations and discuss the possible effects of organizational culture which is seen as an important prerequisite for successful e-learning implementation.

Keywords: organizational culture, e-learning, virtual teams

1. INTRODUCTION

In multinational businesses with global presence, e-learning is recognized as a prerequisite to doing business in manner of development and implementation knowledge through the companies, achieving best results and decrease the costs, respecting different cultural values of employees, as well as other stakeholders. It provides easier adjustment to modern ways of doing business. Organizations tend to recognize themselves as more flexible, identifying major trends of E-learning for employees and managers. Organizational culture playing a crucial role in learning processes, changing processes, communication, competency system which imply business according to the right development in the modern age. Most researchers and practitioners agree that culture, however it is defined, plays an important role in virtually every aspect of an organization's performance.

It was discussed challenges of culture with respect to its impact upon the use of information technology to manage learning within an organization.

2. ORGANIZATIONAL CULTURE

Organizational culture can be defined as "the pattern of basic assumptions that a given group has invented, discovered and developed in learning to cope with its problems of external adaptation and internal integration, and that have worked well enough to be considered valid, and, therefore to be tough to new members as the correct way to perceive, think, and feel in relation to these problems". A given group is a set of people who have been together long enough to have shared significant problems, who have had opportunities to solve those problems and to observe the effects of their solutions, and who have taken in new members. A group's culture cannot be determined unless there is such a definable set of people with a shared history [1]. Corporate culture has a determinant role in the working environment. As per the knowledge-based view theory of

organizational culture, personal ideas are considered as an intangible asset, which plays a vital role in corporate development. It is difficult to define culture as one concept, since it can be defined variously according to perspective or purpose, but culture can be referred to as a collective term of all the things acquired by learning. Accordingly, organizational culture means a culture formed in accordance with organizational goals by sharing the things acquired by learning, and comprises all the values, activities, philosophy, ideals of an organization. Once formed, it does not change easily. It greatly affects the values and behaviours of employees as well as organization performances [2].

3. E-LEARNING

E-learning is often described as a learning process that is delivered, enabled or mediated by electronic technology for the explicit purpose of training in organizations [3]. It is often utilized to foster professional development as it is capable of delivering information and knowledge to individuals across organizations. [4]. E-learning systems can offer multiple stand-alone courses that do not require an instructor's physical presence and learners get to control their own learning process [5].

Adopting information technology (IT) is essential for organizations because it influences work performance, organizational culture and organizational development [6]. IT provides a practical way to deliver information and knowledge within organizations and to support employees' learning opportunities overall. Chen and Hsiang [7] argued that e-learning should help foster a learning organization and an organizational culture based on knowledge sharing. According to some authors [8] informational technologies in global organizations has been used to support learning, enhance performance development and promote organizational development and growth.

E-learning and mobile learning are becoming more popular as an effective method of teaching and learning, disseminating information and knowledge in institutions of higher learning and organizations. However, it continues to be challenging to fully engage all academicians and employees in productive use of the available e-learning offerings. The shift to e-learning and mobile learning represents an organizational cultural change. It needs to be demonstrated to academicians and employees that e-learning is not only about using technology but more about delivering improved and effective methods of teaching and learning.

E-learning systems can assure employees flexible access to learning contents, regardless of the location of the workplace, gender and cultural differences [4].

VIRTUAL TEAMS – in the literature

Authors [9] examined in their paper few questions related to Global virtual teams: 1) what are the cross-cultural challenges faced by global virtual teams? 2) how do organizations develop a knowledge sharing culture to promote effective organizational learning among culturaly-diverse team members? And 3) what are some of the practices that can help maximize the the performance of global virtual teams?

Virtual temas exclusively use information and communication technologies exclude social or physical presence and rely on a depersonalized form of communication between team members. [10] Virtual teams must accommodate diverse national cultural values and norms. Cultural dimensions also extend to the level of teams. At the team level, values, beliefs and norms are observed in team cultures that determine the organization, distribution and coordination, communication and monitoring of work.this characteristics are believed to affect virtual team performance [11]. Virtual teams are considered as one of the new forms of knowledge sharing. These type of teams require state-of-the-art communication and learning capabilities for different team members to effectively work together across cultural, organizational and geographical boundaries. This is feasible with assistance of modern

information and communication technologies. It is important to create a knowledge-sharing culture within virtual teams, providing intra-team respect, mutual trust, reciprocity and positive individual and group relationship. [12]

4. ORGANIZATIONAL CULTURE AND E-LEARNING IN THE LITERATURE

A handful of studies from a limited group of researchers have examined the impact of organizational culture on e-learning.

Yoo and Huang [4] investigated the effect of e-learning systems on increasing development of learning organizations in the service companies in South Korea. In this study, information technologies were used in e-learning systems for communication and assistance in learning and employee development. The results of this emphasises the critical role of e-learning systems for the development of learning organizations within the workplace in South Korea. The authors suggest that HR professionals should consider creating specific roles that would use technology to contribute to creating a stronger workplace culture.

Other researchers argued impacts of cultural differences and have not investigated the cultural impact on the organizational level.

For example, Nathan [13] examined how adults learn and what is the influence of their cultural background on their approach to learning. In this study he focused on manner in which technology is used to deliver learning solutions. He presented several issues in practical learning methodologies caused by technology. For instance, while broadband Internet access is not available everywhere in the world, a single multinational organization may have a slowdown in e-learning. If the learners have access to e-learning technology, the flexibility and potential cultural neutrality of that environment may in fact allow more learning across cultures.

Authors G.Dafoulas and Linda Macaulay[14] research virtual software development teams and how cultural differences between them or their members may affect activities in different stages of the learning. Cultural differences are one of the most important issues that should be addressed for the teams to work effectively. Finally they suggested what kind of support is necessary for effective solve conflicts, how to form teams, how to allocate roles, and how to manage software engineering project in culturally different environment.

5. CONCLUSION

As the available communication media becomes more sophisticated and advanced, while the technology costs are lowering down, the trends in organizational learning will tend to be more and more virtual. Organizations are, and will be, facing many challenges. On the one hand, organizations are being spread across different locations and cultures, while trying to achieve the same goals and be guided with same mission, vision and values. While the researchers are dealing with the challenges of cultural differences it is crucial to stress the importance of fostering the organizational culture that is going to help employees who are different on so many levels to blend in virtual organization of effectively collaborating and coordinating members. While it is important to get a bigger picture in global context, it is also important to shift research on organizational level. Every researcher and manager dealing with organizational culture needs to be aware of the multiplexity and multiple dimensions of organizational culture.

Studying the organization related to e-learning we can conclude that every business has to become global. It means organizational culture have to become global. Over the last few years, differences between national culture become less significant. Using the internet and computers in every field of work and our daily life, differences between people, and as well companies in different countries are reduced. Organizational

culture based on that assumptions make it easier to implement e-learning in the companies. This way companies are faced with challenge to educate and train employees multicultural, to evolve adaptive experiences related to new media uses, to use digital and internet tools in their daily business, to communicate using technologies such as presentations, e-platforms, e-mails and online networks of commerce and exchange. For conclusion, organizational culture should be adjusted to new way of doing business in the age of electronic communications supporting global gender differences, different languages, visual symbols, implementing e-platforms, evolve digital skills of employees and e-communications.

6. ACKNOWLEDGEMENTS

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The Importance of Working Instructions as a Part of the LEAN Initiative

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Abstract

Each production or service system has the appropriate organizational structure. The research that has been conducted shows that in most cases members of this organizational structure don't have clearly defined tasks that they perform. Carrying out the work tasks of employees in such conditions is reduced to an experience that eventually becomes larger. The consequences of this situation are numerous problems, and some of them are that the scope of individuals' work is unpredictable; quality of their performance is often debatable, employee training takes too long, etc. These problems are especially important in cases where workers are often changed. Creating work instructions today is going along with the introduction of ISO standards. Their quality, in most cases, is only to satisfy the ISO documentation format. Research is carried out in the appropriate production facility of textile industry, aimed to investigate the consequences of the state of lack of work instructions in the work processes. In addition, the research will also show the results after creating and using work instructions in individual workplaces, as well as their correlation with the application of the LEAN production strategy in the system.

Keywords: work instructions, process, lean strategy, learning, system

1. INTRODUCTION

The notion of work instructions (WI) is already widely discussed and well-described topic. However, there is a common dilemma for those who create WI, what is the difference between Standard Operating Procedures (SOPs) and WI? When researching and staying in different production and service systems, there was noticeable absence of any written instructions for work in any form. Employees with lower education levels in most cases did not have any information about whether there are instructions for performing work tasks at their workplace. In addition, there is a frequent occurrence and lack of knowledge among workers positioned at higher positions. The largest number of cases indicated that there is not a sufficient high threshold of knowledge in this area or complete lack of information. In some cases, it is noticeable that there are working instructions and procedures in the system, but most employees within the system have no idea what the SOP and WI they need to know in their work position.

LEAN production strategy, which today has a wider application, basically aims to eliminate from the process all activities that do not add value to product in the manufacturing. In most of the observed systems, when searching for a research partner, there was no systematic approach to defining neither the work process nor its individual elements. The question asked is how to apply LEAN in the process if we do not have defined and assigned tasks?

Bearing in mind the mentioned above, a research was conducted aimed primarily at

presenting the situation in this segment of the designing the work process, as well as the consequences of not recognizing the importance of WI in production and service systems. In addition to the current state presentation, the results obtained after the implementation of WI, improvements in certain segments of the production process will also be shown.

2. LITERATURE REVIEW

The research that was carried out was requiring necessary knowledge resources, as well as the appropriate production or service system in which the research will be carried out.

The knowledge that was necessary for research included two areas:

- Identifying the situation and trends in the field of creating work instructions,
- Basic LEAN production strategies.

2.1 Basics of creating work procedures - literature review

The explanation of what WI is in the literature is often interpreted in various ways. Basically, it can be said that WI are in a broad sense, which include instructions delivered in both verbal form (words, communicated orally or in writing) and non-verbal form (pictures, images, models, gestures, etc.) [2].

There are more types of work instructions. Written work instructions are easier to create, but are not very suitable for operations with complicated tasks that can be found in complex production systems. Rather than that, visual work instructions take place. Not only for that, but according to the learning pyramid (refer with: Fig. 1) a recipient remembers about twice as much of all information if these is conveyed through visual content [3,4].

However, it is not uncommon for the literature to find cases in which the Standard Operating Procedure (SOP) and Work Instruction (WI) are identified. SOPs do provide instructions for workers. However, they are intended to include "why" a task is performed, in addition to simply "how" to perform the task [5]. The difference between SOP and WI is that WI is lower on a hierarchical scale of business documentation [5].

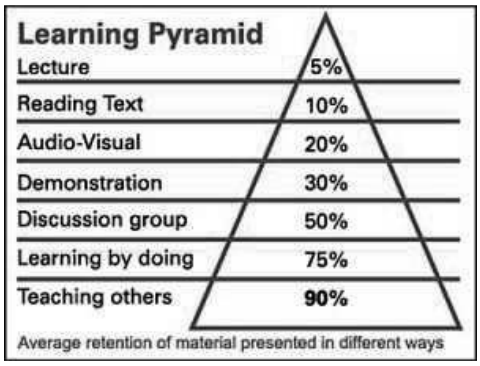

Fig. 1: Learning efficiency pyramid [3,4]

How high the importance of work instructions is best illustrated by the research carried out in that field. In line with these surveys, new approaches and technologies for improvement in this area are being developed.

Some of the areas are: how WI should look [3], creating dynamic work instructions [8], electronic and multimedia WI [9, 10], etc. From this, it can be noted that in this area, there is a very active wide area of research that converges to one goal-the adoption of standards for WI which gives the best results in the result of the application.

2.2 Lean as production strategy

Lean as a production strategy increasingly becomes the standard in production systems. The development of new production systems often involves the application of LEAN within its production processes.

What is the basis of the LEAN approach is difficult to explain briefly. There are different views on this issue, but it is quite possible to accept the opinion that its essence is described in five principles [6, 7]:

- *Defining values* - market research and defining the product that the customer needs. Only the product that the buyer is willing to pay at a certain price is a value.

- *Mapping the flow of values* - by moving through the assembly process, the product gets value only in certain parts of the process. In order to see the whole situation and see the zones in which there is no added value, it is necessary to create a flow-value map.
- *Creating a stream by eliminating* losses - the observed losses in the previously created flowchart of the value flow should be eliminated, all with the goal of establishing a continuous flow.
- *The demand response* - the created value flow should be able to respond to customer requests. In this situation, customers only withdraw products when they need it.
- *The pursuit of excellence* - no matter how perfect it looks, the designed system certainly contains parts of the process that still generate losses.

It is worth mentioning that the corresponding LEAN terms (often referred to as tools, techniques, LEAN methods) are used to achieve these five principles. The most common are terms such as 5S, SMED, Poka Yoka, Visual Management, Value Stream Mapping, Standardization, etc.

LEAN approach, in the result of the application of the aforementioned concepts and principles, improves the performance of the production systems and creates conditions for the continuous elimination of losses from the production processes.

3. METHOD AND MATERIALS USED FOR RESEARCH

The research that will be presented is carried out in the textile industry. In its character, the production system is at the transition between medium-sized and large-scale quantity production. The system is characterized by a wide production program.

The first part of the activities was carried out with the aim of identifying the integrity of the process as well as the flow of materials, which are (Fig. 2):

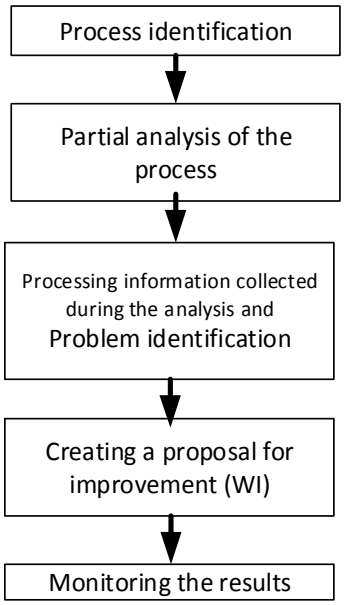

Fig. 2. Conducted research activities

The factory consists of several separate units, each of which functions almost independently in relation to other parts.The process as a whole consists of (Fig. 3):

- knitting unit,
- sewing unit,
- unit for painting preparation,
- painting unit,
- packing units.

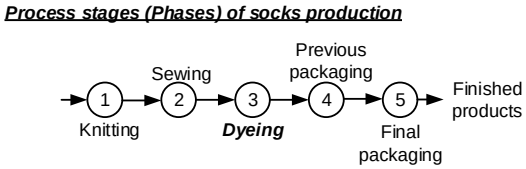

Fig. 3. Stages (Phases) of socks production

Also, interviews were conducted at different levels to gain full insight into the technology being implemented and the knowledge that comes with it. It was found that the level of education is very low, many of which are even illiterate. According to the number of employees, the company belongs to medium-sized enterprises (more than 250 employees). In order to extract certain segments of the process

for carrying out the research, this part of the information collection proved to be very important in this regard.

3.1 Partial analysis of the process

After production process has been mapped and defined, wider analysis of individual elements of the system and individual jobs has been conducted.

Analyzes were carried out to a wider extent in the part located in the knitting part, partly in the seam and in the end, because of the complexity of this production part and the nature of the work tasks, a part of the painting process was selected.

Fig. 4 Part of the knitting plant in which the analysis was carried out

The analysis was reduced to conducting interviews with workers at different levels in the organizational structure. The interview was conducted with workers in the control of products in the part of the knitting unit, with shift managers and machine workers. Similarly, interviews were conducted in other parts of the process. In addition, the method of direct observation was used.

Information on the status and quality of the applied technology and its modernity were collected. Particularly in this section emphasis is placed on the maintenance of the system as well as the situation in that sector.

Each of the analyzed jobs did not require a high level of education. When it comes to work operations, mostly workers were with elementary school.

3.2 Processing information collected during the analysis

The processing of information gathered in the production process has shown that for all operations in the process, the basic problem is the absence of any work instructions, regardless of the type of work being done. The quality of performance of work operation mainly relies on the work experience of the worker and the individual attitude towards the work tasks. It was very often critical to advocate individual workers in carrying out their work tasks. The lack of knowledge was justified by the low level of education in certain parts of the process as well as the individual characteristics of the workers.

Cause-related links between the lack of work instructions for describing work tasks and problems that occur are shown in the table (Table 1).

The above data in Table 1 should be a sufficient argument when discussing the need to introduce WI into work processes. Of course, it should be borne in mind that for the comprehensive creation of work instructions in production and service systems, you need to invest in WI creation. However, the spectrum of the consequences of their non existence is an entirely sufficient argument for stepping in that direction.

4. SOLUTION PROPOSAL FOR IMPROVEMENT

Based on the information and conclusions made in the table (Table 1), it was decided that one of the first steps for improvement in the system would be to prepare a WI instruction. The preparation or creation of a WI is for conducting the experiment in workplaces with the highest intensity of work and the most needed training, due to frequent changes in the workers and where the results will be most rapidly achieved after the introduced changes.

Table 1. Corelation between WI missing and the problem occurrence

WI missing causes a problem:	Explanation	Consequence
1. Uneven product quality	Workers work according to their experience so that they do not have a standard work assignment	Inequitable product quality
2. Difficult capacity planning	There are no clearly defined norms that are related to work instructions	There is no clearly defined capacity
3. Inability to plan worker load	Workers are often manipulated by work obligations due to lack of norms	Reduced level of worker utilization
4. Worker dissatisfaction	Different attitude towards work is caused by a conflict between workers	Poor working atmosphere
5. Difficult training of workers	There is no WI so training is extensive	Trainings are often poor and incomplete
6. Extended training of workers	There is no WI, so it often depends on the one who is implementing it	Loss in time and effect
7. Reduced safety	There are no clear instructions on potential workplace hazards	Endangered worker safety
8. Difficult adjustment of production	As a result of employee change, it is difficult to manage capacities with variable quality and the number of workforce	Frequent changes slow down production and reduce the degree of capacity utilization
9. Reduced working discipline	It is difficult to maintain a work discipline without corresponding KPI indicators	Because of the inability to control
10. Difficulty gathering information from the process	It is difficult to get to know the process of work and, therefore, to notice KPI	The nodes of information are not clearly visible
11. Loss of workers knowledge	Workers can hardly be involved in LEAN and KAIZEN events without clearly defining their responsibilities	Small number of promotional proposals submitted
12. Difficult management	Without discipline and clearly defined norms and load capacity	Reduced productivity
13. There is no motivation to involve employees in business processes	Passive and indifferent attitude towards the workplace and obligations without the desire to improve	Non-inclusion of workers in acquiring knowledge
14. Unstable business processes	Stress caused by a constant threat of failure to fulfill the production plan	It varies quality and productivity
15. Worse interpersonal relations	The diversity of doing the same or similar tasks and the results achieved, are the main cause of the conflict. It is especially expressed when the work is paid according to the norms	There is no communication between the workers. Expressed intolerance
16. Inability to control the consumption of materials in the process	Undefined tasks leave room for inadequate use of available materials	There are no written rules of material consumption
17. Undefined competencies of individuals	Failure to perform work tasks	Overheating or avoiding work
18. Inability to correctly design the production system	Undefined time capacities prevent correctly designing work tasks and work places	Large losses caused by poor lay-out project
20.etc.		

The most commonly present point in creating work instructions was that it was unnecessary. However, research has shown that the existence of a vacuum in the WI section left room for individuals to carry out work activities in the "original" way, resulting in the creation of large losses of materials, energy, product quality and most importantly - time.

When creating WI, special emphasis is placed on their appearance-form. The following figure shows the part of the WI prepared for the knitting process (Figure 3) of the article, and a similar procedure is made in the sewing and painting section of the article.

For the creation of WI, a transitional solution from the pyramid of learning efficiency was used to a large extent. A method for learning by reading in combination with visual add-ons was used. The subject of the research was also the creation of the appropriate audio-visual material for giving instructions, which is by its efficiency from the learning pyramid to a somewhat higher

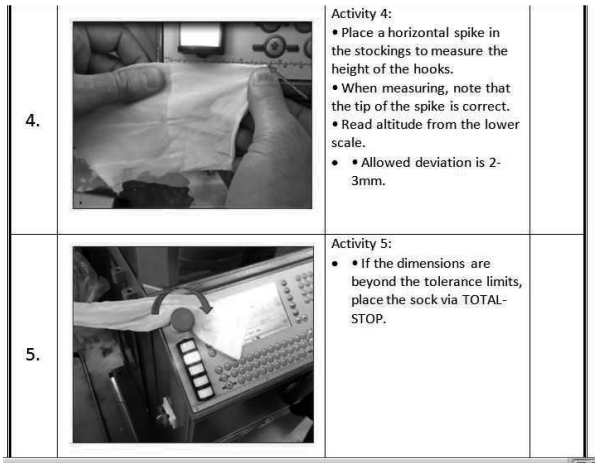

Fig. 5. Partial view of WI

quality. Standard cameras with standard video were used to create these instructions. Basic problem was non-inclusion of workers in knowledge acquiring.

5. RESULTS AND ACHIEVEMENTS

The application of the appropriate WI solutions for certain jobs, but with the first applications, gave good results. Some of the training that lasted several months was significantly reduced. Material prepared in the form of work instructions has significantly relieved the obligation to transfer knowledge to older workers. Until then, the usual way of training has significantly reduced the stress of those who transfer knowledge and those who need this knowledge in new circumstances. The previous training period has significantly burdened the relationships between older and new workers caused mainly by dissatisfaction with the transfer of knowledge. Older workers generally expected faster acceptance of transferred instructions. New employees have to some extent shown dissatisfaction with the quality of the way knowledge transfer. Also, the lack of confidence in the field and the volume of knowledge transferred are expressed. The dynamics of knowledge transfer is an important element of the training process.

The application of WI has managed to help workers better recognize the boundaries of their obligations and expectations regarding the quality and safety of their tasks. As a result, a large number of suggestions for improving the performance of work tasks were obtained. Also, a large number of proposals have been received in terms of improving both the appropriate technical solutions and technology.

5.1 First conclusions after application of WI in practice

A large number of problems mentioned in the previous table (Table 1) with the application of WI in practice began to slowly disappear in the first iteration. Training in individual workplaces, which lasted for two months or more, could now end in a shorter period (approximately seven to ten days and in some cases shorter). Training could have been exempted to a certain extent those who had previously been engaged in this job. With the creation of the WI, conditions have been created for the quality of knowledge and training to be able to deal with other people, which significantly "pushes out" from training the scope of the problem that was previously there. Of course, the greatest problem and scope of work was that appropriate work instructions had to be developed for all work tasks and for all tasks.

Particular emphasis in this research was partly placed on the type of work interactions that will be applied. In this sense, the corresponding number of audio visual WIs has been created. The first uses of this form WI showed slightly better results than the conventional approach described above (Figure 5). The workers responded positively and accepted this approach better. However, the sample and time of the study, until writing this report, were not large enough to statistically quantify the comparative results of these two WI creation approaches and thus performed a comparative analysis. What is perceived as a certain limitation in the application of audio-visual WIs is the creation of technical capabilities for their implementation. The previous version does not require expensive IT support. The method of realization of audio-visual work instructions requires better training

in the implementation of multimedia applications, which is in itself an expensive process. Also, the infrastructure for use is more complex. When creating work instructions in the original case, it is possible to work parallel to the development of WI.

6. CONCLUSIONS

The impact of WI on the withdrawal of a large number of problems, identified during the research, shown in the previous table, is a extensive work. It is necessary to spend a longer period of time in order to determine the factual situation in this regard. The time and method of reacting the system to the proposed improvements is a very important parameter. In order not to draw prematurely and insufficiently confirmed conclusions, it is necessary to continue the research.

In addition to the results directly and indirectly related to WI instructions, it is important to emphasize that the LEAN initiative also began to play its roots. A large number of suggestions for improvements, as well as communication with employees at different levels of the organizational structure, are the first indicators of things going in the right direction.

7. ACKNOWLEDGEMENTS

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Evolution of ERP Systems in SMEs – Past Research, Present Findings and Future Directions

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Abstract

Today, industries are trying to improve their competitiveness by combining business per se with information technology. Modern management relies heavily on information as a necessary resource for developing other resources and gaining advantages over the competition. Information system is a system that through formalized procedures provides managing at all levels in companie with appropriate information based on data from internal and external. Enterprise resource planning (ERP) system is one of the most widely accepted choices to obtain competitive advantage for manufacturing companies. Since ERP systems have a major impact on SMEs, in this paper is given literature review about past development and research, present findings and future directions in ERP systems.

Keywords: ERP systems, SMEs, information technologies, cloud ERP

1. INTRODUCTION

Growing importance of competition in market and continuous pressure on raising enterprises operations efficiency results in searching for new solutions and technologies, and increases importance of modern IT systems. Modern management relies heavily on information as a necessary resource for developing other resources and gaining advantages over the competition. Information system is a system that through formalized procedures provides managing at all levels in companie with appropriate information based on data from internal and external. Enterprise resource planning (ERP) system is one of the most widely accepted choices to obtain competitive advantage for manufacturing companies. The Enterprise Resource Planning (ERP) system is an enterprise information system designed to integrate and optimise the business processes and transactions in a corporation.

Enterprise Resource Planning (ERP) system is a package used for planning enterprise resources, composed of integrated modules which manage all of the core business processes of the organization. Main objective of the system is to seamlessly incorporate business processes within and across the functional and technical boundaries in the organization with improved workflow, standardization of business practice and access to up-to-date real time information [1].

ERP systems are considered cross-functional and process-centred and are designed to improve key operations such as e.g. finance, accounting, human resources, purchasing, manufacturing and sales [2]. Within ERP systems, these key operations are called modules and organizations traditionally purchase these modules individually based on their needs [3].

2. METHODS AND MATERIALS USED FOR RESEARCH

Literature reviews represent a well-established method for accumulating existing knowledge within a domain of interest. The research methodology used in this study is the review of literature on ERP systems. The period of publishing was set to the years between 2000 - 2018 in order to narrow down the search. To find relevant articles for this review, various keyword searches were in the KOBSON, Google Scholar, and IEEE Xplore databases. The search was made using keywords such as enterprise resource planning, enterprise resource planning performance measurement, enterprise wide systems, Cloud ERP, Cloud Computing and etc.

3. WHAT IS ERP?

ERP is a software system aims to integrate all functional units of the enterprise in a cooperative way. It may also extend to include parties outside the enterprise for example supplier and customer to involve them in the integration.

Fig. 1. ERP Database [5]

Enterprise resource planning (ERP) systems are software packages composed of several modules, such as human resources, sales, finance and production, marketing, distribution, providing crossorganization integration of information through embedded business processes. Comprehension the history and evolution of the ERP system untill today is essential to understand importance of ERP systems for the business of an organization. In many aspects, ERP system is designed to overcome the operational problems that the organization has experienced.

3.1. Definition of ERP system

"Enterprise resource planning (ERP) has come to mean many things over last several decades. Within the literature, different authors have defined ERP in a different way, for example, according to Jacobs and Bendoly [12], ERP can be defined as a concept and as a system.According to Davenport (1998), ERP systems generally comprise different software modules, which allow organisations to automate and integrate the majority of business functions by accessing, and sharing common information, data, and practices across the enterprise in realtime [14].

Akkermans et al. [13] also state that ERP can be defined from different perspectives such as functional, technical, or from business perspective that provides strategic value encompassing the entire organizations.

Tarantilis et al. [17] define ERP as a system that integrates traditional accounting, manufacturing, sales, management, and other management products to offer an "all-in-one" solution that deals with all business management aspects of organizations.

"The heart of an [ERP] system is a central database that draws data from, and feed data into a series of applications supporting diverse company functions. Using a single database dramatically streamlines the "flow of information throughout a business."[18]

At the operational level, Gable defines ERP as a "comprehensive packaged software solution, which seeks to integrate the complete range of business processes and functions in order to present a holistic view of the business from a single information and IT architecture." Similarly, Nah et al. and Stemberger and Kovacic define ERP systems as a "packaged business software system that enables companies to effectively and efficiently manage resources (material, human resources, finance etc.) by providing a total integrated solution for an organisation's information-processing needs." [15], [16].

3.2. Evolution of Enterprise systems

The fundamental structure of enterprise systems date from the early fifties of the twentieth century, with the introduction of computers into business. In the 1960s, production systems put a focus on stock control and how to manage large quantities of supplies in the most efficient way. In that period, first applications automated manual tasks such as bookkeeping, invoicing, inventory managemen. and reordering.

The early inventory control systems (ICS) and bill of material (BOM) processors gradually turned into standardized material requirements planning (MRP). The development continued in the 1970s and 1980s with the MRP II and CIM concept [6]. The term Enterprise Resource Planning is originally coined in 1990 by The Gartner Group to describe the next generation of MRP II software [7]. ERP evolved from material requirement planning (MRP) and manufacturing resource planning MRP II systems. MRP and MRP II systems were designed to systemically link different aspects of process information within specific business context such as manufacturing [8]. In the 2000s ERP systems evolved from enhancing operational efficiency to supporting competitive advantage innovations and strategy [7].

With time passing ERP systems faced a lot of evolution and upgrade processes to enhance its functionality and increase the integration capabilities. According to [5] ERP is a key element of an infrastructure that delivers a solution to the business. The need for soloving some information problems leads to extending concept ERP to ERP II. Modern ERP systems (ERP II) are built for use over the internet. It enhanced with e-commerce capabilities and the ability for integration and collaboration with suppliers, partners, customer portals, and enhanced tracking of incoming row material and outgoing final products to extend the visibility and control inside and outside the enterprise [9].

ERP II systems share common data in a real-time environment that enable management and employees to have a unified view of all business functions across all departments [10]. ERP II focuses mainly on company's supply chain area. The ability to reduce company costs throughout operations as well as managing vendor and supply chain issues is what ERP II functions are known for. Companies have been relying on ERP II for a number of years to produce higher quality products at a lower cost. With all of this in mind, the main function of ERP II is to add operational excellence by allowing you to "think outside the box" when it comes to supply chain processes.

The integration of customers (single customers as well as corporate customers) into an ERP systems lays in the essence of the ERP III concept. It may be adapted by the implementation of the last and most sophisticated achievements in IT. The focus of ERP III is not only real customers but also potential customers. Thus market information about future sales may be analyzed and integrated into ERP systems taking account of real business transactions. Extended marketing analytics are key features of ERP III [11]. The ERP III concept which is the most newly known concept focuces on implemetnig cloud computing and GRID technologiest in ERP systems. The vendors of ERP like Oracle, SAP, PeopleSoft, J.D Edward, etc. developed different modules to cover and support all functional units of the enterprise.

4. FUTURE DIRECTIONS

New trends change the way organizations deploy services, platforms and infrastructure of Information Technologies. Nowadays, "the cloud" has been a buzzword in the last few years and has caused a revolution in the Information and Communication Technologies (ICT) industry [21]. In an environment of global competition, there is a growing recognition of the central role of IT in determining the overall success of organizations. Enterprise Resource Planning (ERP) systems have played an important role in the integration of business

Table 1. Enterprise systems in retrospect

Decade	Concept	Function
50	Inventory control systems (ICS	Forecast and inventory management
60	Material requirement planning (MRP)	Requirement calculations based on bill-of-material (BoM)
70	Manufacturing resource planning (MRP II)	Closed-loop planning and capacity constraints
80	Computer-integrated manufacturing (CIM)	Automation, enterprise models
90	Enterprise resource planning (ERP)	Integrated processes
00	Enterprise resource planning (ERP II)	Integrated processes, internet integration
10	Enterprise resource planning (ERP III)	Extends ERP I and ERP II (integration between manufacturing enterprises and their downstream partners – mainly customers)

functions within organizations to support the generation of products and services [19].

In today's highly competitive business landscape, the trend for organizations is to focus their resources and efforts on what they do best and leave the supportive services in the hands of more specialized third parties. The world's economic model in IT today is moving from "buy and own" (on-premise) to a subscription based, payper-use (cloud-based) model. The migration from traditional (on-premise) ERP to cloud-based ERP could help organizations to manage their costs efficiently and improve their operations [21]. Cloud-based ERP provide organizations with the possibility to choose the provider that best suits their needs, eliminating inflexible traditional on-premise ERP solutions.

4.1. Cloud computing

Cloud computing has become new promising trend of computing which left the attention in the academic researches and as well as in the software industry. As IBM states "Cloud computing, often referred to as simply 'the cloud,' is the delivery of on-demand computing resources, everything from applications to data centers over the Internet on a pay-for-use basis" [20]. According to Gartner, cloud-based services can be defined as "massively scalable system capabilities delivered as a service to external users using Internet technologies" [22].

Cloud computing is a computing environment which provides availability, scalability, and flexibility of computer reassures at a deferent level of abstraction with low running cost. Cloud computing can be defined as a computing method to provide computing as the utility to meet the everyday needs of the general business community.

The cloud computing services provided in three models[24], Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). Software as a Service (SaaS), targets the end user or business. Platform as a Service (PaaS) is the delivery of middleware which contains tools, services and platforms targeted the software developers, to allow them to build SaaS application. Infrastructure as a Service (IaaS) is the delivery of computing power hardware and software targeted towards administrators. Cloud ERP systems belong to Software as a Service (SaaS).

4.2. Cloud ERP

Nowdays the success of cloud computing combined with the increasing pressure on organizations to respond to unique customer needs in the increasingly competitive business environments of today, has given rise to the new model for ERP, also referred to as cloud-based ERP or SaaS ERP. This new model of ERP systems functions in the same way as a traditional ERP systems. Infrastructure is the main difernece

between traditional ERP system and Cloud ERP. The ERP in a SaaS model is accessed over the Internet while the application and data is controlled by the cloud service provider and offered as a "ready-to-use" product to the end client for a monthly subscription fee [23].

A cloud-based ERP system uses the advantages of cloud computing to offer a new and more flexible approach to host and use ERP systems. The Cloud based ERP system should be accessed via the user browser over the internet without installing or configuring the system at the user side [18]. Benefits which Cloud ERP brings is that the enterprises do not need to pay for building the computing environment it just pays for accesses the environment over the internet. Also, working over the cloud allows the enterprise to access and use specialized technology and advanced computing resources available over the cloud.

5. CONCLUSION

In very dynamic business enviroment, ERP systems are widely spread and fast developing in recent years. The base concept ERP containing mainly the MRP and MRP II concepts are going further. The need for fast integration with suppliers, vendors and customers leads to creating the ERP II concept. ERP II is a concept where mainly downstream partners are integrated. The ERP II concept has the idea to integrate upstream as well as downstream partners in supply chains. The ERP III concept is mainly influenced by the development of new IT such as service-oriented architecture, cloud computing, business intelligence and knowledge management.

New approaches to ERPs turns some of the weaknesses of traditional ERPs into benefits. The main benefits of cloud-based ERPs are its scalability and lower investment costs, creating opportunities for SMEs. However, the main weaknesses and threats to this new approach are the security. Regard of this, some of the next research will be dedicated to increasing the security of the new generation ERP systems.

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The Unemployment Problem and Its Consequences in the Republic of Croatia

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Abstract

Unemployment is a major problem of today with far-reaching consequences. The consequence of unemployment is not just the decline in financial power of individuals, ie. poverty, but also the cause of many disorders such as stress, depression, emigration. This paper examines the problem of unemployment in the Republic of Croatia and poverty as its consequences, and this is precisely the case in the last decade, especially in recent years, as one of the main reasons for emigrating Croatians to more developed countries. The aim of this paper is to show the unemployment as the fastest growing problem of the Croatia. The aim is to identify the causes of unemployment, the impact of the crisis on the reduced need for labour force, and this will be achieved by identifying the reasons why a large number of people emigrate. In this study is included the analysis of the collected statistical data and it will also analyse the data on the actions that need to be taken to ensure that emigration, if not completely eradicated, than reduced to the lowest possible rate.

Keywords: unemployment, Croatia, emigration, poverty

1. INTRODUCTION

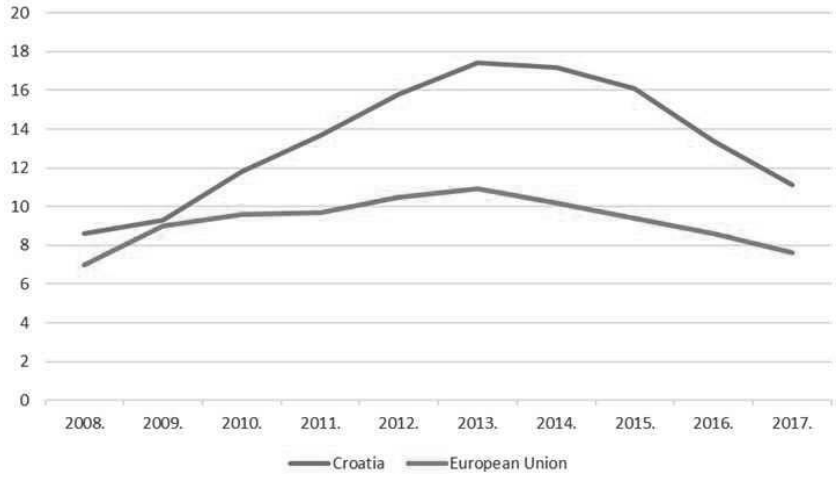
Due to the great world and economic crisis, unemployment in the EU member states and the Republic of Croatia as one of the members increased, and therefore an attempt to reduce unemployment and increase the number of employed persons has become one of the priorities of the European Council and the European Parliament. Unemployment in Croatia is a long-standing phenomenon that today is among the biggest problems of the Croatian economy. High and long-term unemployment can have significant social and psychological consequences. A large number of unemployed people in Croatia are long-term unemployed. A social group that is particularly affected by the growth of unemployment is a young people, ie active working population aged 15 to 24 years. That is why one of the consequences is the "brain drain", the emigration of highly educated people with a clear vision of their own skills, overseas due to lack of job offers, inadequate working conditions, unsatisfactory pay or poor working conditions. Croatia with relatively weak economic growth in recent years increasingly feel a lack of workforce.

2. UNEMPLOYMENT IN REPUBLIC OF CROATIA

"Unemployment is a condition in which part of working-able members of the society can not be employed adequately with their abilities and qualifications, with the usual salary."[1] Unemployment is a rooted, not a local, but a global problem, whose solution requires a long process with quality determinants and a high degree of renunciation in order to feel progress and reduce unemployment. It can be said that the crisis in the world was largely caught by

Croatia, which, as a small and insufficiently developed country, did not have the ready answers and ideas to overcome instability in the global sector.

The most obvious consequence of the crisis is the spreading or loss of the middle layer and division not to the rich and the poor, but to the extremely rich and extremely poor. As the middle layer almost dwindled, it can be said that the curve that would show the ratio of financial status to individuals simply "suffers" because it shows data indicating two opposite and incompatible extremes. The unemployment rate is an important measure of a country or region's economic health that shows graph that follows.



Graph 1. Unemployment rate in Croatia and European Union [Authors according to 2]

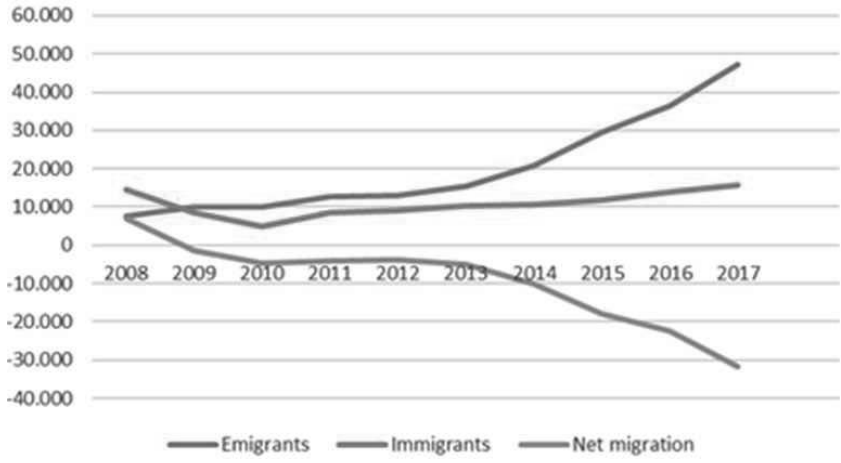
The graph 1. shows the trend of unemployment rate in Croatia and European Union from 2008 to 2017. The graph shows that the unemployment rate in Croatia as well as in EU is increasing from 2008. The peak is 2013 year. The rate in Croatia was 17,4%. Although the unemployment rate has been reduced, it is still at a high level and much higher than the European Union average.

As far as data for 2018 is concerned '"Eurostat estimates that 17.207 million men and women in the EU-28, of whom 13.656 million were in the euro area (EA-19) were unemployed in May 2018."'[3] The unemployment rate in the EU in 2018 (February) has been declining on a monthly and annual level, and similar trends have also been registered in Croatia, which is included in the Eurostat report in the group of countries with the largest drop in the annual unemployment rate. According to Eurostat figures, Croatia slipped to 9.6 % in February this year, from 9.8 % in the previous month. The reason for this is probably the high demand for seasonal workers, the outflow of young people abroad and the increasing number of unemployed people who do not report or leave the Employment Office for various reasons. "By far the lowest unemployment rate among EU member states recorded Czech Republic, the unchanged 2.4 %. Following are Malta and Germany, with 3.5 %, and Hungary, with 3.7 % in January. The highest rates of unemployment are still in Greece, with 20.8 % in December 2017, and Spain with 16.1 %." [3] According to a statement by the European Statistical Office, Croatia was ranked again in the group of countries with the largest drop in the annual unemployment rate. Still, it may be expected that future unemployment will fall slower because there is not much room for further reduction in the number of unemployed.

3. IMPACT OF UNEMPLOYMENT ON THE EMIGRATION OF RESIDENTS FROM THE CROATIA

Young people are strongly focused on finding a job and they are aware of the fact that finding an adequate job is what can provide

them first money, and then getting to know new people, and thus enabling career advancement. However, the problem of unemployment in Croatia is not only affecting younger but also older people. Middle-aged people are often marginalized as "unnecessary" because there is a belief that they cannot follow the trends for their years and that what they have learned in the current working age cannot or will not change, and do not match all variants of the same workplace tasks and job descriptions. In addition, young people after completing high school or college have a problem finding a job. Since they have no experience or can have, opinions are emerging about their lack of interest in learning and following the policy of the company they are starting to work on. It is precisely the problem of the existence that stands out as the biggest problem, and there is an insufficiently developed standard of living, as well as a lack of motivation and perseverance in seeking an adequate place of work. The record decline in unemployment is partly due to the mass emigration of the population. However, data on the movement of the number of employees indicate that things in the labour market are still improving. In recent years, we have witnessed significant emigration from Croatia, but it is difficult to ascertain exactly how it is measured by the decline in unemployment. The following table shows international migration of population of Croatia.



Graph 2. International migration of population of Croatia [Authors according to 4]

Graph 2 shows emigration, immigration and net migration from 2008 to 2017. It shows the rising trend of emigration from Croatia, which is the result of a bad net migration.

4. CAUSES AND POTENTIAL SOLUTIONS OF UNEMPLOYMENT

An attempt to reduce unemployment and increase the number of employed persons is one of Croatia's top priorities. Primarily, work is indispensable so that young people can find and secure stability and realize their aspirations. If young people are in an environment where this dream is unavoidable, there is a possibility of increasing instability and that of social instability. Social stability is the pillar in trying to improve the state of the state. In addition, unemployment becomes such a problem and one can even say that it reduces rights that are guaranteed, both older and especially young people.

The reasons for the lack of job supply on the market are a bad and uncertain economic situation, but it is necessary to analyse the problem in several areas. Although there is no document in which the reasons for unemployment are to be quoted, it is easy to conclude that the lack of education related to the development of the profession and the reduced, limited and halted economic growth are sufficient reasons to create a mismatch between supply and demand on the labour market. In

order to eliminate this problem or at least to the lowest possible level, it is vital for young people to have existential security, which can be supported by designing and starting their own business, either by self-employment or by opening up larger companies. The person who is now deciding to start his own business can be called bravely, and although the market situation is uncertain, every effort to solve the unemployment problem is praiseworthy. That is why the EU offers Measures of Active Employment Policy: "Training aid, Self-employment support, Education of the unemployed, Training at work, Professional training for work without establishing a working relationship, Public work, Support for job preservation, Permanent season "[5]

It is not enough just to achieve the right to a certain measure, but it is necessary to respect the agreed conditions. Without trusting relationships, all measures can only be properly displayed on paper, but if they are used in practice only for financial relief, then it only creates a springboard for emigration.

The EU has enabled its members, including the Republic of Croatia, to use financial support and employment measures, thus helping to combat unemployment. The lack of knowledge of potential entrepreneurs is associated with a lack of information on the possibilities of using material resources received by the European Union. People are often afraid to risk, and although they want to change, they have a sense of fear of failure. The establishment of one's own company and its survival in the Republic of Croatia is not only for the individual but also for the homeland itself. Employment aid means better paying power for individuals as well as their families, which will ultimately result in greater inflow of money into the state treasury. Unemployment causes a completely reverse result. A jobless person has no compelling power, his costs will be reduced to a minimum, which means a total of less money to the state. It is difficult to predict its end as well as the consequences, but only by dealing with the problem, it can be successfully and lastingly solved. A big problem is uncertainty for young people to go looking for a better life because they do not know when and will they even find a job that meets their demands. In addition, it is a worrying fact that people have a job in Croatia, often a regular job with regular income, but abroad can earn much higher incomes and thus provide better financial resources. Strong reliance on the tourism sector causes a significant seasonality in movements in the Croatian labour market, with instability or short-term employment, but also the demand for specific occupations needed in that sector.

As one of the problems, also an education system is quite flexible for labour market needs, so that the new labour force entering the labour market often lack the knowledge and skills required by employers while adapting to the dynamic dynamics of the globalized world. In addition, there are relatively high labour costs compared to some comparable countries in the environment, while employees are often low in terms of living costs.

5. CONCLUSIONS

Unemployment is a global problem faced by a large number of people in the Republic of Croatia every day. To resolve this problem, it is necessary to improve the economic situation in the country and to open new jobs that need to be safe. The labor market and employment are influenced by many factors that need to reverse in order to improve trends. Although the rate of decline is always a case in the interpretation of data, it is necessary to observe a wider context and never make conclusions alone on the basis of one figure.

One of the biggest problems is the lack of entrepreneurial initiatives, but also the general apathy and the state of society without optimistic expectations for the future. Recovery on the labour market is noticeable, but it is mostly about passive causes. The problem of unemployment remains a key issue for the development of the labour market in Croatia.

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Development of Rural Tourism in the Municipality of Oriovac

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Abstract

This paper deals with the initiative of the Municipality of Oriovac and the Tourist Association of the Municipality, which aims to launch rural tourism and its further development with the intention of creating a new branch of economy in the area of the municipality. The paper also analyzes the existing resources for rural tourism, the existing opportunities and advantages for tourism development, but also the problems and disadvantages that are a potential barrier for future development of rural tourism. The municipality has created a Strategy for rural tourism development in the area of the municipality, which defined the advantages and disadvantages and set specific tasks, vision and goals that should initiate the development of rural tourism. The goal is to make municipality Oriovac an attractive rural tourism destination that attracts more and more visitors every year with its preserved natural and cultural assets. In this way, the municipality plans to achieve a visible shift in improving the existing economy and raising the quality of life in its area.

Keywords: turism, rural tirusm, Municipality of Oriovac

1. INTRODUCTION

Tourism is a separate activity, a separate industry that is daily dependent on global influences, primarily economic, climatic, communication, information, technological and other. Therefore, tourism is experiencing constant and varied changes depending on the changing lifestyles of people, but also seeking for constant innovation of tourism products, changing and new experiences, new emotions and depednds on educational, cultural, socio-psychological and many other parameters.

Although rural tourism has an increasing popularity and there is a growing interest in the world tourism market, there are still a number of constraints on rural tourism development, which are manifested through the lack of a long-term development vision, very little awareness of the possibilities of dealing with rural tourism, as well as insufficiently qualified human resources, which significantly slows the possible development of tourism in rural environments. Because until recently there was no planned deliberation on the development of tourism, the development of the Tourism Development Strategy for the municipality of Oriovac has great importance in managing the tourist development of this region. Only deliberate strategy, building the necessary tourism infrastructure and the creation of tourist products which already has the necessary resources, can become recognizable and interesting destination for rural tourism.

2. TOURISM AND TOURIST PRODUCT

Tourist destination is travel destination and with its attractions it represents the basis of

tourist offer or tourist product. Tourist destination includes a wider, integrated space that builds its tourist identity on the concept of cumulative attraction, allowing experience and with additional tourist infrastructure represents a gathering place for tourists. The tourist destination is conditioned by the wishes, preferences, interests and needs of tourists. [1] Tourist product is made of products and services of series of different economic and uneconomic activities (hotel management, restaurant industry, traffic and communal infrastructure, trade, manual trade, sport, entertainment, culture, tradition, ethnosocial characteristics of local inhabitants and other) but the satisfaction of tourists with some destination depends on more widely factors as hospitality, security, state of life surrounding, arrangement of environment, communal infrastructure, climate circumstances and other. [2]

In many countries where tourism is an important part of economic activity, strategies and plans with visions of tourism development, strategic goals and action plans are brought to the national level. However, in decentralized societies, it is the cities and towns that are the basic level of planning and administration. [3]

3. TOURIST RESOURCES ON THE TERRITORY OF THE MUNICIPALITY OF ORIOVAC

The important structure in tourism and tourist development makes area with all its components, population and its characteristics and features, geographical and natural characteristics, material and immaterial values, customs, sights and specialties in the ecological and gastronomic offer of this area and region.

A significant role in creating a tourist destination brand has a destination management. Traditionally, the destination is considered as a mix of direct and indirect tourist facilities (eg accommodation, catering, public and private transport and roads, visitor information, recreational amenities, etc.), and a wide range of natural and cultural tourist attractions (e.g. landscapes, monuments, experiences, etc.) that are offered to tourists during his or her stay in a selected place or destination. However, for economic and marketing science, the tourist destination is more than a recognizable geographic area. Very often tourists experience the destination as a whole, so that the area is not only considered as a "tourist place", but also becomes a "tourist product" “. [4]

The elements of tourist destination quality include all that what is offered to tourists on certain area. Those elements are: infrastructure (traffic and communal), state of life surrounding and arrangement of environment, culture and entertainment, sport and recreation activities, hotel and catering buildings, informing tourists, shopping, characteristics of local inhabitants (culture, tradition, folklore, hospitality), security and protection of guests (life security, health security and property protection). [2]

3.1. Natural Tourist Resources

In the area of the municipality, the climate of continental features prevails in warm summers and relatively cold winters and is suitable for a better development of rural tourism. The slopes of Dilj and opposite them, the lowland area along the Sava River and the Jelas field and ponds are an excellent place for a pleasant stay in nature and for sport and recreational activities such as sport fishing and alike.

Jelas field and complex ponds measuring about 800 hectares in which carp is mainly cultivated with other types of freshwater fish as well, surrounded by the typical rural, Slavonian landscape, oak forests and meadows. It is a habitat for many and varied, very rare species of waterbirds, gray heron, white-tailed eagle, spoonbill, black-headed gull, several species of ducks and others, which is an excellent tourist resource with the potential to develop a specific form of "bird watching" tourism which is very popular with people who love nature. Ponds are important nesting ground, winter habitat and feeding ground for rare and protected waterbirds, as well as otter habitat.

The wider area of the pond evaluated as the IBA (Important Bird Area, Natura 2000) also has exceptional tourism potential, and with additional active protection measures, and small investment in tourism infrastructure (e.g. interpretive panels and bird observation posts) and quality promotion, can turn into a recognizable tourist product, since it is an important nesting gruond, feeding srea and winter habitat for birds and habitat of other animal species (e.g. otter and spruce). Up to now there are recorded over 230 bird species, of which 122 species are nesting birds.

The Orljava River, which springs under the Psunj mountain and in the area of the municipality of Oriovac flows into the Sava River is also suitable for the development of fishing tourism and as excursion site. There is also the Lake Čaplja in Oriovac, an artificial lake created in the middle of the 20th century, which is nowadays regulated and maintained by the municipality and sport fishing association "Sharan" from Oriovac. It is registered in the Croatian Fishing Water Registry and as such can be included and used as a significant tourist resource. Next to the lake there are sports fields for basketball, indoor football and similar sports which the municipality plans to renovate and arrange and which could also be part of the tourist offer.

The fauna of these water and fishing areas consists of many spieces. About twenty of them are considered to be endangered and very rare, while forty species are strictly protected by the Nature Protection Act. There is also a very diverse flora which, along with other natural resources, makes this area an attractive and high quality natural resource for the development of future tourism. In the area of the municipality there are hunting societies "Orljava" from Slavonski Kobaša and "Oriovac" from Oriovac that have been using and looking after the four hunting grounds. There is a variety of wildlife such as wild pigs, roe deer, rabbits, pheasants, deer, wild cats, marten and other wildlife that is common to this area and which is an important resource for hunting tourism.

3.2. Social Tourist Resources

Social resources of tourist area make all objects, all manifestations, events and occurrences that contribute to the creation of a recognizable tourist product. These resources are divided into cultural-historical, artistic, environmental and manifestation resources. Additionaly, various monuments of culture, sacral objects, archaeological sites and similar locations are also an important social tourism resource.

Archaeological excavations in the area of the municipality of Oriovac revealed the traces of different cultures from several periods. Findings in the form of remains of dwellings, tools and bones point to the presence of the Sopot-Lengyel culture in the period from 3100 to 1300 BC. The finding of stone arrows, clayey ballast for making fishing nets heavier, stone axes, stone blades, scrapers and drills indicate that the population was engaged in hunting and fishing. From the Neolithic period, on the wider territory of Brod-Posavina country were found the remnants of Baden, Lasinja, Kostolac and Vučedol culture from the period from 2400 to 1850 BC.

Findings from the Jelas field in the form of decorative dishes reveal Brod culture from the younger Bronze Age. Close to the necropolis in Oriovac, which is located at 95 m above sea level, is found a large number of graves with urnes and remains of bones and ashes of deceased. In the Malino settlement, remains of the Celtic necropolis were found together with the iron sword and spearhead that were put in the graves of warriors. Nearby are also found the remains of prehistoric gold jewelry from the late Bronze Age.

3.3. Sacral Heritage

In the area of the municipality there are several churches of exceptional architectural and historical value. Church of St. John the Baptist and the Church of the Blessed Virgin Mary at Kloštar in Slavonski Kobas and Church of St. Emeric in Oriovac are on the list of protected cultural goods of the Republic of Croatia.

Cultural monuments from the older and those from a recent history, attract tourists and fans of cultural and monumental values. In the area of the municipality, all the already mentioned cultural and sacral objects from older history, as well as recent ones, have a particular importance for the population of this area and they are certainly interesting and attractive to tourists and passers-by. The Municipality of Oriovac has many different associations that organize various manifestations and events, all of which can, with better organization and good marketing, become part of the tourist story and tourist product of future rural tourism in the municipality.

4. DEVELOPMENT OBJECTIVES AND MEASURES

In order to encourage and motivate family farms to engage in tourism, the municipality has created a Rural Tourism Development Strategy as a fundamental document that should point to opportunities, strengths and weaknesses that slow down the development of tourism. A key step in the development of this strategy was SWOT analysis, which defines strengths and weaknesses, as well as opportunities and threats for future tourism development. The SWOT analysis also determined development goals and measures to achieve desired success in the development of tourism. The principles and specialties of the municipality which promise optimum management of the existing resources have been taken into account, as well as the potential supply and demand parameters. An important detail that must be an integral part of the tourism development strategy of the municipality is the promotion of tourism and tourism activities that actually links the factors of supply with the factors of demand.

The development goals derived from SWOT analysis are:

1. Improvement of tourism infrastructure and other public infrastructure necessary for tourism development
2. Development of selective forms of tourism
3. Promotion of the destination and education of tourist parties for joint participation in the tourist market

The basic assumption for the development of tourism is a quality and maintained tourist infrastructure. The tourist infrastructure consists of wine roads, cycling trails, promenades, gazebo, bird watching towers, hunting lodges and similar locations. Resources such as forests, hunting grounds and water resources should be used. With the promotion of tourist products and tourist destinations, it is important to educate tourism stakeholders and local residents to point out the opportunities and benefits of tourism to them. It is also necessary to create a specific brand of this destination, as well as a recognizable original souvenir of the municipality, whose creation should involve all potential stakeholders in tourism.

5. CONCLUSIONS

The municipality of Oriovac is an area that has many different advantages that can be foundation of future rural tourism development. The benefits are preserved and diverse nature and natural resources, rich Slavonian gastronomic and wine offer, geographical position, two rivers (Orljava and Sava) and other water areas, protected landscapes of Jelas fields with rare and protected species of waterbirds.

Insufficient number of tourist family farms, lack of accommodation capacity and inadequate cooperation between the public and private sectors, are the also disadvantages that slow down the development of tourism. The tourist association of municipality of Oriovac tends to initiate tourism development through the construction of tourism infrastructure projects. The development of the Rural Tourism Development Strategy is also an indicator of the readiness of the municipality of Oriovac to initiate tourism activities. Therefore, the municipality and the Tourist association of the Municipality of Oriovac will monitor the tenders of the Ministry of Tourism and the Croatian

National Tourist Association to apply for development projects in tourism, cultural heritage conservation projects and encourage families to engage in this branch of the economy.

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Employment Status and Risk Aversion: Do Money-Makers Care More for the Money?

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Abstract

The scope of this paper is to present results of risk aversion testing among two different groups: employed money-makers and unemployed, when probabilities of outcomes are unknown. The reason for testing was to establish if there is difference in risk aversion under ambiguity between subjects who earn money for themselves and subjects who currently do not earn money for themselves. Previous researches suggest that older, more experienced and employed decision-makers tend to be more risk averse than younger, inexperienced and unemployed decision-makers, however most of those test were done in laboratory environment using methods that usually do not reflect situations that could be met in reality. Methodology for risk aversion measurement in this research was based on stock-market simulation, with the data better suiting the real behaviour of investment decision-makers. In the research it is not confirmed that employed subjects are more risk averse than unemployed subjects, but that unemployed decision-makers, when faced with investment decision under ambiguity, will approach it with the caution, while decision-makers who earn their payments will be more reckless. Implications of this research can be used both by policy makers and investment institutions on order to formulate an approach to different types of investors according to their employment status.

Keywords: risk aversion, investment decision-making, decision making under ambiguity

1. INTRODUCTION

No matter how important, decisions are part of people's daily lives, more often that they realize. From the simplest ones to more complex, people make numerous decisions in just one day. However, business decisions are approached with more attention since they can cause significant financial gains or losses for business and individual. Because of the monetary dimension of the decision, decision makers tend to more cautious and implement some form of decision–making tool, which usually require some resources. However, no matter how developed or high-tech business decision support is, there is always room for different influences, both external and internal.

Emotions and human nature are hard to pass-by, so new approaches in decision-making process try to integrate behavioural approach into decision-making theory. The concepts such as loss aversion, risk aversion, and heuristics are being extensively researched since the publishing of the Tversky and Kahneman work in 1979 and their publishing of the prospect theory principles. Since then, behavioural approach in decision-making has become widely accepted part of decision-making theory.

One of the relatively unexplored differences among decision makers is the difference between decision makers that earn their money and those that don't. Because there are different influences, both external and internal, on the process of decision-making, it is important to

understand attitudes towards risk of decision-makers with different personal traits.

2. DECISION-MAKING

The decision involves choosing from a set of at least two options (alternatives, actions) to which we can achieve the desired goal. If we have only one option, then there are no dilemmas regarding the choice, and therefore there is no problem of decision-making. [1] Options must be defined so that they mutually exclude each other, while the set of options must be final in order to be able to speak about the correct alternatives.

The goal of decision-making process is to come with the best possible alternative that will maximize the positive aspects and minimize the negative aspects concerning the choice. However, for that to happen, there must be enough information about the alternatives, the probabilities should be known and decision-makers must possess enough knowledge, experience, tools and resources in order to process information in the best possible way. However, decision-makers often do not have adequate information about the core of a problem; they do not have time or means to get information and often are incapable to understand the given information. They are facing the impossibility of memorizing so many information and limited ability of counting. [2] Those situations are called bounded rationality. Investors are often subjected to bounded rationality due to the quickly changing prices and trends, and decisions must be made in the shortest time possible.

2.1. Programmed and Non - Programmed Decisions

Depending on the previous knowledge and experience with the problem, decision-maker faces two types of decisions: Programmed and non-programmed decisions. Programmed decisions are those decision whose basic characteristics are the routine performance of activities, the predetermined procedures for making the decision and the experience by which decision-making is made. [3] Programmed decisions are characterized by their predictability since they the problems to witch decisions are related to tend to occur regularly, regardless of their complexity. Hence the programmed decisions are based on practices, rules and procedures that are result of past experiences. The decisions are usually decomposed on elements that can be defined, predicted and analysed in order to create best-practice documents, procedures or policies that will help with making programmed decisions.

Non-programmed decisions are those decisions that decision-makers make for the first time and are related to new problems without pre-destined algorithm for its solving, with increased uncertainty compared to the programmed decisions. Behavioral theory is of great significance in making non-programmed decisions because it views decision-making process as a sequential, repeating process of alternative elimination. The rationality is applied on one choice among possible choices that satisfy given criteria of decision-making.

2.2. Optimal and satisfactory decisions

Depending on the clarity and probability of the outcome of the decision, two types of decisions can be identified: optimal and satisfactory decisions.

Optimal decisions are those decisions that maximize the outcome of the action, either being financial outcome or some other type. They are usually made in such cases where there is enough information and the possible outcomes of actions are clear and the process of decision-making concerning optimal decisions is connected to the classical theory of decision making. Much of the optimal decisions can be made by using decision-making software. Also, mathematics, statistics and algorithms are often used in making optimal decisions.

Satisfactory decisions arose from the cases in which optimal decisions couldn't be made due to the lack of information or the probability distribution. Given that financial utility can't be

measured, satisfactory decisions present solutions that are "good enough" given the circumstances. The goal of making satisfactory decision is to bring the decision-maker least possible regret concerning the decision. Satisfactory decisions find support in behavioural decision making theory, which states that psychology, anthropology, philosophy and other social sciences have influence on decision-making of the individual.

2.3. Decision-making process

Decision-making process is a part of broader process called problem solving, which includes these phases:

- Current situation (initial state) observation and problem identification;
- Precision problem definition;
- Goal definition (of choice criteria);
- Alternative action (option) direction identification;
- Information gathering;
- Alternative evaluation;
- Choosing the alternative;
- Action implementation;
- Results dissemination and analysis. [4]

By valuating efficiency (overseeing the results) it can be concluded if the decision has made expected outcome. In that way decision-making process can be presented as a system with its own subsystems that are interconnected and influence one another. [5]

The process of decision-making is passing though several stages:

Collection and analysis of needed information;

- Business system goals definition;
- Expected results elaboration;
- Decision concerning resources needed;
- Alternative decisions elaboration;
- Choice of the decision;
- Decision implementation. [6]

The goal of decision-making process is to help the decision-makers choose the best possible alternative among several alternatives given the information that are available.

2.4. Experience differences among investors

The difference among decision-makers with different previous experiences have been thoroughy researched, especially among workers with different entrepreneurship background. Researchers found different risk aversion levels among public and private sector workers, where private sector workers exhibit less risk aversion behaviour [7]. Risk-tolerant individuals can benefit more from the entrepreneurship training than risk-averse individuals [8], supporting the claim that entrepreneurs are generally more risk tolerant than other individuals.

The attitude of decision-makers according to their employment status has been researched; however the results of different researches are somewhat in contradiction. While Halek and Eisenhauer [9] found that unemployed subjects in their research are much more prone in financialy risky behavior, Pannenberg research showed that unemployed job seekers are risk averse [10].

3. RISK, UNCERTAINTY AND AMBIGUITY

Risk represents the state where numerical probability for occurrence of certain events is known, such as in case of a coin toss, where the probability for either heads or tails to occur is p=0.5. The decision-making under risk is common practice in programmed decisions, because the frequency of occurrence can provide decision-makers with a number of instances and better probability calculation.

In case where there is no known probability, but the probability can be calculated from past events by using statistical methods or by expert opinion, decision will be made in uncertainty. Uncertainty represents risk where the numerical probability is set with smaller degree of confidence due to the either lack of necessary information or different use of given information by different decision-makers.

Ambiguity is defined as a decision environment when there are no probabilities that decision-makers can assign to the outcomes of their actions. This situation usually happens when decision-makers are dealing with new problems.

Investors usually work in either uncertainty or ambiguity. In the case of the investments, the future cash flows are usually projected on the basis of current market situation and the results of the similar projects in the past. However, not all investors possess the knowledge or experience needed to interpret data in a way that would help them maximize their wealth. In their case, even with the information that is provided to them, they make decisions under ambiguity.

4. INVESTMENT DECISION-MAKING

Investments represent conscious renunciation of current consumption in order to acquire larger gains in the future. Although the term investment is colloquially associated with finance, investments can be made in other domains as well, since money is not the only resource that can be invested. However, humans as decision-makers doesn't always maximize their incomes from decisions, as first described by Bernoulli in 1713, but their decision is ruled by the expected utility that the actions/consequences of their decisions will have upon them. Namely, not all gains are measured equally.

Prospect theory, set by Tversky and Kahneman in 1979 and expanded in 1992, define that decision-makers are influenced by the psychological factors more than it was believed before, and that humans are often unable to make optimal decisions. This is due to the two phase decision model, which consists of preliminary analysis of the choices given and their simplification (editing phase) and later evaluation. Because decision-makers during editing phase are susceptible to the certain psychological effects, their decisions are not in line with the expected utility theory. [11]

Effects that, according to the behavioural economist influence decision-making are numerous, and some of better researched are:

- Loss aversion: One of the basic phenomena of choice under both risk and uncertainty is that losses loom larger than gains. The observed asymmetry between gains and losses are to extreme to be explained by income effects or by decreasing risk aversion. [12]
- Heuristics – represent the wide group of psychological tools that help decision makers during their decision-making process under bounded rationality. Heuristics doesn't necessary help decision-makers make best decisions, but they just speed-up the process of decision making, sometimes leading to the decisions that are neither optimal nor satisfactory. Notable heuristics include anchoring, representativeness, availability, etc.
- Risk aversion – Decision-makers are risk averse in that sense that they prefer sure gains over possibility of larger gains coupled with the possibility of loss.
- Ambiguity aversion – people prefer lotteries with known probabilities over those with unknown probabilities.

Investors decision-making under ambiguity is characterized by the lack of information given to the investors, or misunderstanding of the information due to the lack of knowledge. As it is almost impossible to come to the precise probabilities of directions of price movements on the market, it can be argued that investors work either under uncertainty or under ambiguity, with the prior experience, knowledge and access to information making the difference between the two states.

Although there are certain models of decision-making under ambiguity, such as method for measuring loss-aversion under ambiguity by Abdellaoui et al [13], those models are not suitable for the research of

investors, due to specific scenarios in which investors operating on the stock exchange might find them. The stock market, in contrast to the most models, is not a lottery, meaning that the maximum gain can't be measured. Also, the usual volatility of the prices presents a problem, because most of the methods take linear approach to the price change, which is usually not the case. However, most of the researchers found that the coefficient for loss aversion is in a region of 2, meaning that people tend to ask for two units in case that one unit can be lost. Although widely accepted, some researchers found that current evidence current evidence does not support that losses, on balance, tend to be any more impactful than gains. [14] Gal also contest that loss aversion is not responsible for some of the effects it produce. [15]

5. METHODOLOGY AND SAMPLING

To measure ambiguity aversion under risk, we prepared an on-line questionnaire. The research was done as a part of PhD thesis research on models of decision-making under the ambiguity. The subject group consisted of the current and past students of Industrial engineering and management department of Faculty of technical sciences, University of Novi Sad. Total of 214 invitations were sent, of which 145 were opened and 89 answered the research, of which 50 were women, and 63 were employed at the time. The choice of such subject group was done in order to have a subject group that either has a theoretical or practical knowledge of the stock market principles, as the researches wanted to find out how investors with knowledge and/or experience on the market react in situations under ambiguity. The research was anonymous. The questions were on Serbian language. There were no infractions of the process and not a single result was dropped.

The questionnaire was divided into three parts, of which two will be presented. The first part consisted of questions concerning date of birth, employment status and gender of the subject, as well as his previous knowledge and experience about stock-market exchange. The first part was used as a check of consistency, as all students who received invitations for research either attended courses connected to the stock-market exchange or were part of the simulation.

Second part of the questionnaire was presented as a hypothetical scenario in which subject took the role of the investor with a certain amount of financial resources. They had a choice of three different stocks that had the same price. The only difference between the stocks were the spread between the potential gains and losses, as the first one had small spread, meaning smaller potential gains and smaller potential losses, second had larger spread between potential gains and losses, and third was presented as a stock with both high potential gains and losses. The only information that subjects had been given is that the market is stable and it is predicted it will remain stable in the near future. By not giving information needed for the proper assessment of the stocks, the subjects were put under ambiguity for the decision making, as no probabilities were given.

Service used for distribution of questionnaire and collection of answers is sogosurvey.com, and excel was used for graphical and statistical presentation of the results.

6. RESULTS AND INTERPRETATION

The result show that unemployed decision-makers exhibit higher risk-aversion under

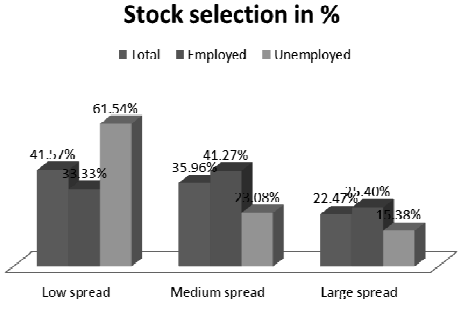

Fig. 1. Stock selection depending on the gain-loss spread among different groups

ambiguity than employed decision-makers, which is in contrast to the previous researches. The results of the research can be seen on Fig 1. The risk-aversion among all subjects follow the pattern of risk aversion in general, however it can be noted that employed subjects exhibited more risk-tolerating behaviour, and where inclined towards risk-neutral behaviour (26 to 21).

7. CONCLUSION

Differently to the expectations and somewhat previous researches, we found that unemployed decision-makers will be more risk-averse than employed ones. This result could provide that among our subject group unemployed subjects tend to value their money more than their employed counterparts, which gives a notion that unemployment benefits will not be wasted and that it will be respected among those in need.

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University Key Performance Indicators – Students perspective

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Abstract

Systems of Key Performance Indicators - KPI's in universities has become very popular tool not just for measuring progress of the achieved goals as a basis for more efficient resource allocation, but also for informing stakeholders and comparing instituions. One of the main issues in the process of designing system of KPI's is the selection of appropriate indicators which directly depends on the purpose of the system and on the stakeholders view. The objective of this paper was to select relevant performance indicators from the students perspective, as one of the most important stakeholders, as a basis for developing performance indicators system, and to present their use for the purpose of more efficient resource allocation. Students were expected to give their opinion of relevance and actual values on each performance indicator which was than used for comparing the relevant (desired) value of indicators with their actual (observed) value, providing further guidelines for improvement and better resource allocation. Perfomanse indicators were selected by ranking most relevant indicators, from students perspective, using Mean-Variance methodology which were than compared to their actual value. The survey included a sample od 204 student form the area od Industrial Engineering and Engineering Management within the field of Technical and Technological Sciences in Serbia. Results showed the gap between desired and actual value on all relevant indicators, which indicates the existance of systemic deviation caused by systemic factor pointing further to the need for realocating reosurces in the most relevant areas of student interests.

Keywords: Key Performance Indicators, University, Students, Relevance.

1. INTRODUCTION

Higher Education Institutions in Europe and all over the world have experienced significant changes in the last three decades. Rapid growth and development of world economy, followed by the development of new technologies, caused strategic objectives of the education systems to be redefined in order to provide their further development. In the knowldege based society, where the value of intangible assets greatly exceeds the value of tangible assets, the develoment of new knowledge, experience and skills, took one of the primary places, changing also the world of higer education. This caused many factors to change, resulting, in the first place, in an increasing number of students all over the world, but also in regional integration of higher education institutions and systems, the growing internationalization of the instututions, their diversification, incerased privatization, and so on [1]. Trends listed above, together with growing complexity of higher education systems caused the decline in the quality of teaching due to mass enrollment of students, increase of total costs of studying, etc. In addition, the traditional relationship between government and universitiy has changed. More and more, universities today are expected to justify rational use of resources, to demonstrate value for money and to be transparent [2]. At the same time, students are investing their time and money, focusing not

just on gaining university degree with good potential for employment, but expecting much more from the whole process od education, inculding “enjoyable extended period of personal and social development” [3]. Similarly, employers are expecting to get skilled work force with sufficient knowledge in the specific area of education. Therefore, it is evident that Higher Education Institutions are operating in the complex environment, fulfilling the needs of various stakeholders, all of which are expecting different objectives to be met.

All mentioned above, caused the need for development of a systems that will provide informations for improving the management of institutions, and at the same time for informing interested parties. Also, the interest for comparing institutions is growing regionaly and on international level resulting in an emergence of numerous rankig systems. Therefore, it was necessary to focus on systems for measuring and monitoring the parameters of quality, that is, to the introduction of key performance indicators (KPI) that are used in the assessment of the real state of the business and determine the main directions of action in the future [4].

In the process of development of performance indicators systems in universities, one of the main challenges is the selection of indicators with respect to different stakeholders perspectives. Depending on the purpose of indicator system, different criteria are used for selection of performance indicators – relevance to stakeholders, availability of informations, comparability, validity, reliability, etc.

This study explored the criteria of relevance over the set of performance indicators among one specific group of stakeholders – students, as a basis for developing performance indicators system. Also, students were expected to give their opinion of the actual value on each performance indicator which was than used for comparing the relevant (desired) value of indicators with their actual (observed) value, providing further guidelines for improvement and better resource allocation.

2. SYSTEMS FOR MEASURING PERFOMANCE

Systems for measuring performance in companies evolved over time. Traditional systems, in the past, were primarly focused on financial data [5] which was in line with the economic and business concepts of that time, when the value was created and expressed on the basis of tangible asset. Over the last three decades, the value of companies is not based solely on the tangible assets, but also on intangible assests, which are not completely included in the accounting balance sheet and are mostly related to the value arising from intelectuall capital [6]. This caused lack of ability of old systems to portray the whole picture of company performances, and it was clear that it was necessary to include non-financial measures, when developnig systems for measuring performances. Among the first, Kaplan and Notron [7] concluded that performance measures must be regarded as an integrated system in the function of an organization's strategy. On that basis, new systems, like BSC (*Balanced Scorecard),* or SMART (*Strategic Measurement Analysis and Reporting Technique*), etc., emerged and very soon found their application not only in profit but also in non-profit sector. Specific characteristic of HEI’s, such as absence of profit motivation in public universities along side with diversified objectives, makes measuring performances very difficult [8], which made this type of performance indicator systems more suitable for use.

3. DESIGNING SYSTEMS OF PERFORMANCE INDICATORS

Before selecting appropriate performance indicators, the first step in developing system of performance indicators is defining the purpose for designing such systems. Most authors agree that the systems of performance indicators in higher education are commonly used in one of the following purposes: evaluation, monitoring, planning, dialogue and resource allocation [1], [9], [10]. These roles are not mutually exclusive,

but they are driven by different forces which further affects the choise od appropriate performance indicators. For example, systems for planing and improvement need informations from organizational processes that use managers. The issues of evaluation and efficiency are mostly the interest of government which uses different indicators to contol for policy fulfillment and incentives, etc. These different roles require different criteria which are used for selection of indicators such as: relevance of indicators for different stakeholders, reliability, comparability, validity, availability of information for calculating indicators, multidimensionality, measurement, resistance to manipulation, etc. In ths paper, the selection of indicators is focused on the criteria of relevance of key indicators for stakeholders with a focus on the students population.

Generaly, the problem of selection of appropriate key performance indicators reflects on the quality of informations that are being provided. The main reason is that performance indicators represent an attempt to portrait the whole complexity of the system in a balanced vay. A larger number of indicators is difficult and expensive to monitor and it creates ”information noise“, and vice versa, the smaller number of indicators can not provide the whole picture of complex environment. Also, the one who is selecting indicators is imposing his aspect on quality of entity, and that is why it is very important to explore which indicators are relevant to different stakeholders [10].

4. RESULTS AND ACHIEVEMENTS

In this paper, the results of the research of the relevance of university key performance indicators from the students perspective in the area of Industrial Engineering and Engineering Management within the field of Technical and Technological Sciences in Serbia will be presented.

As a measuring instrument for this research, the questionnaire was developed, using the framework and principles from U-Multirank project [11]. The questionnaire was designed to represent all ever used indicators from [11] which were adapted to the Srbian language as well as to the specific caracteristics of the higher education system in Serbia. First, the questionnaire was tested in the pre-test phase checking the content validity of the questions individualy with 20 students enroled in the study programmes in the area of Industrial Engineering and Engineering Management. The results of the pre-test were used to improve measurement scales in the questionnaire and the comprehensibility of the content. As a result, the final questionnaire contained 64 particles, two of which were control variables (gender and enroled year of the stdudy) and on 62 questions, students were asked to gave their opinion on the relevance of the indicators and their opinion on the actual value on each of the offered performance indicator. To measure students opinion on relevance and actual value of the indicators, a Likert scale was used in which respondents were offered to express their agreement or disagreement with the statement on the scale from 1 to 5, with grade 1 - I completely disagree and grade 5 - I completely agree. The questionnaire was distributed to the students enroled at the second, third and fourth year of Bachelor studies and to student enroled in Master studies from the Faculty of Technical Sciences in Novi Sad and Technical Faculty “Mihajlo Pupin” in Zrenjanin both within University of Novi Sad, and from the Faculty of Mechanical Engineering, University of Nis. From the nearly 2.000 students enroled at this programmes in three different Faculties (without students enroled in the first year), the questionnaire was completed by 204 respondents. Female and Male respondents (*Table 1*) participated almost equally with 59.3% and 40.7% respectively.

Table 1 - The ratio of respondents by gender

	Frequency	Percentage	Valid
Male	83	40.7	40.7
Female	121	59.3	59.3
Total	204	100.0	100.0

Percentage of respondents from 2nd year of Bachelor academic studies (BAS) was 14,7%, from 3rd year of the same level 52,2% and from the 4th year 15,7%. From the 1st year of Master academic studies (MAS) totaly 17,6% students participated (*Table 2*).

Table 2 - Ratio of respondents by enrolled year

	Frequency	Percentage	Valid
BAS 2nd year	30	14.7	14.7
BAS 3rd year	106	52.2	52.2
BAS 4th year	32	15.7	15.7
MAS 1st year	34	17.6	17.6
Total	204	100.0	100.0

Data, gathered from students, was analysed using customized version of Harry Markovitz's Mean-Variance method [12]. This method was used in order to get the list of ranked indicators in order of relevance to the students population. It is based on calculating the mean value and the standard deviation for each question. The mean value indicates the level of relevance of the indicators for the respondents, and the standard deviation shows the measure of the uncertainty of the respondents in the relevance of the each indicator. Indicators with higher value of the mean and the lower value of the standard deviation are considered to be more relevant to respondents than in the oposite case.

Due to the limited space of exposition, only the 10 most relevant and the 5 least relevant indicators, out of 62 indicators in total, are presented in the Table 3 and Table 4.

Table 3 – The most relevant indicators

Rank	Indicator	Mean	St.dev.
1.	C23	4.66	0.635
2.	C17	4.63	0.693
3.	C19	4.55	0.690
4.	C07	4.51	0.803
5.	C02	4.49	0.839
6.	G10	4.47	0.850
7.	C14	4.43	0.831
8.	C20	4.45	0.855
9.	G09	4.43	0.854
10.	F10	4.42	0.873

Table 4 – The least relevant indicators

Rank	Indicator	Mean	St.dev.
58.	E10	3.27	1.300
59.	F08	3.17	1.347
60.	D05	3.08	1.280
61.	C10	3.07	1.279
62.	E11	3.02	1.252

It can be seen that the 10 most relevant and 5 least relevant indicators remained the same as in the pilot-research [13] but their rank order changed slightly.

According to Table 3, the indicators that have the highest relevance for the respondents include: C23 - Availability of information through the Faculty website; C17 - Possibility to conduct professional practice during the studies; C19 - Organization of teaching; C07 - Laboratory equipment at the Faculty; C02 - Possibility of employment after graduation; G10 - Possibility of employment in companies from the region; C14 - Laboratory equipment at the Faculty; C20 - Interpersonal relations at the faculty (the relation of other students and teachers towards me); G09 - Possibility of conducting professional practice in companies from the region; F10 - Possibility of employment in international companies.

According to Table 4, the indicators that are of least relevance for the respondents include: E11 - Citing scientific papers of my professors in patents; C10 - Number of students who completed their doctoral studies at my Faculty; D05 - Quotation of teacher work in scientific journals; F08 - The number of foreign students who have obtained a Ph.D. in my Faculty; E10 - Earnings from sold licenses.

After the process of ranking, the mean values of relevant (desired) value of indicators is compared to the mean values of the actual (observed) value of indicators according to the students opinion. The results of the comparison are presented in Table 5 and on the spider chart on Figure 1.

The results unambiguously shows that there exist the gap between relevant (desired) value and actual (observed) value of indicators according to students opinion, which indicates the existance of systemic deviation caused by systemic factor pointing to the need for realocating reosurces in the most relevant areas of student interests in order for further quality improvements. Students consider the most relevant indicator to be C23 - Availability of information through the Faculty website. Also, the actual value of this indicator is quite close to desired value (*Table 5 and Fig. 1*), showing that this indicator is not just the most relevant indicator for students, but that it meets students expectation on much higher level than other indicators. However, student experience web site not just as a place where they can get all the relevant informations, but also as a tool that saves their time when applying for an exam, a certification of a semester, communicating with Faculty members, etc, which all indicates that it is of great importance for students to develop on-line communication and on-line solving of administrative issues.

Table 5 – Difference between desired and actual value

Rank	Indicator	Mean_ Relevant	Mean_ Actual	Difference
1.	C23	4.66	4.11	0.55
2.	C17	4.63	3.51	1.12
3.	C19	4.55	3.95	0.60
4.	C07	4.51	3.68	0.83
5.	C02	4.49	3.77	0.72
6.	G10	4.47	3.25	1.22
7.	C14	4.43	3.75	0.68
8.	C20	4.45	4.02	0.43
9.	G09	4.43	3.21	1.22
10.	F10	4.42	3.24	1.18

Also, indicators C02, G10, and F10, which fall into the group of factors related to employment opportunity, are rated among the most relevant indicators. All of them, with two indicators which also scores among the indicators of highest relevance for students C17 - Possibility to conduct professional practice in enterprises and G09 - Possibility of conducting professional practice in companies from the region, points to the need to develop a long-term relationship between the Faculty and enterprises and to establish a model of professional practice at the highest level of quality. That is significant signal for higher education institutions to invest time and effort in developing the most suitable model of students internsip, as it is shown in some positive examples in [14] and [15]. It is also very interesting to notice that indicators C07 and C14, which both found their places in the first ten most relevant indicators out of 62 in total, are measuring the same thing - Laboratory equipment at the Faculty. Indicator C14 was set in the questionnaire as a control question which was used to verify answers and to control for acquracy and consistency of the questionaire. Their close values confirmed that students were responding carefuly and with neccesary atention to all other questions which makes all other anwers more valid. Also, these answers confirmed that quality of Laboratories is also highly valued among student population and that they represent one of the most valuable infrastrucuture resources in which Faculties should be investing in order to meet student expectations.

The indicator with the smallest gap between desired and actual value is C20 - Interpersonal relations at the faculty (the relation of other students and teachers towards me) indicating that students expectations on this issue are most close to be met. It shows that there exist a good academic climate on the Faculties that is fruitful for fostering cooperation and mutual exchange of knowledge, skills and experience. However, the indicator with the highest gap between desired and actual value is G09 – Possibility of conducting professional practice in companies from the region. This is a very clear message from students that the internship in regional companies is very highly valued, but that their expectations on this issue are least fulfilled considering all other indicators among first 10 most relevant. These represent the potential for further imrpovements and places where Faculties should invest more efforts and resources in achievening students expectations.

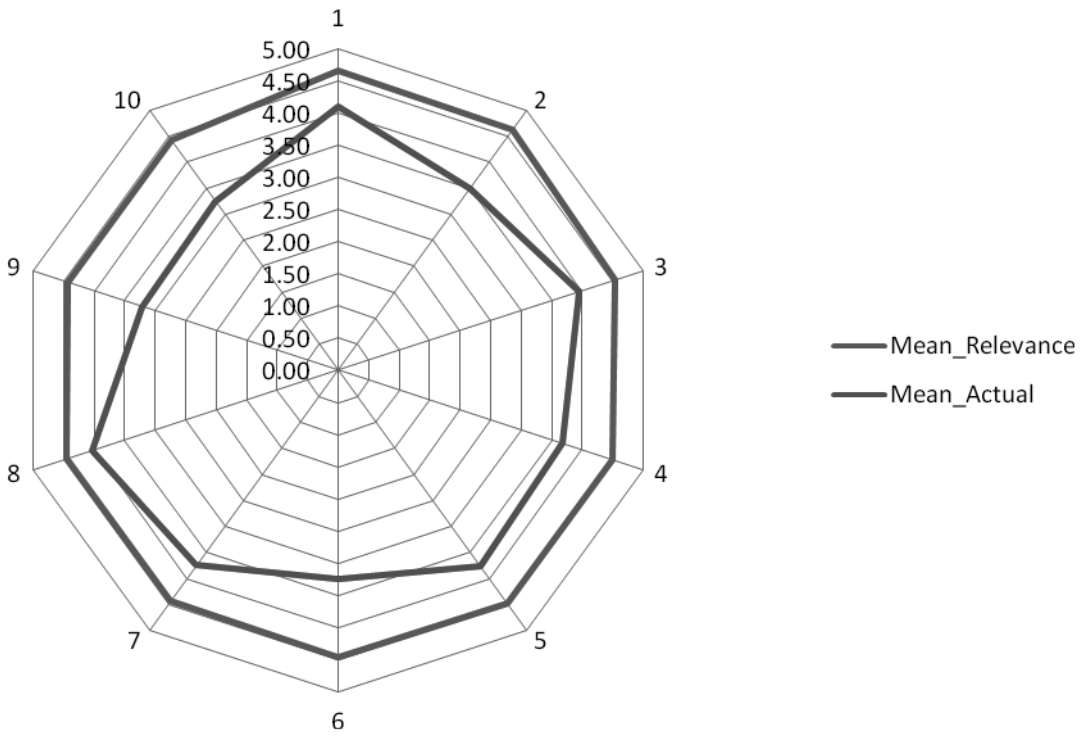

Fig. 1. Comparison of the relevant (desired) values to actual (observed) values

5. CONCLUSIONS

This study indicated student's opinion on what it is important to be measured in Higher Education Institutuions and where the scarce resorces should be allocated to make significant improvements of the quality of system. First of all, the results showed that there exist a broad concesuns of the student population in the area of Industrial Engineering and Enginering Management in Serbia and their awareness on which indicators are considered to be of relevance when measuring quality of institutions and study programmes.

The main conclusion that can be drawn from analysis and comparison of students opinion on desired and actual value of indicators is that their values are not nearly equal. It is obvious, at first glance, from the diagram presented on the spider chart, the existance of deviation of actual values from desired values on all relevant indicators. Also, it is clear that this deviation on all indicators has one direction, ie, the desired values are higher than observed values considering all relevant indicators. This implies that this is not an issue caused by a random, but systemic deviation, indicating that students generally expect indicators to be of more higher value than the actual values are, considering their opinion.

This conclusion only implies that further causes of the problem should be looked for and that search should be focused on finding the systemic factor(s) that have affected the occurrence of systemic deviation. This results can not be taken as a coincidence and should be observed more carefuly with respect to limitations of the research and considering Serbian higher education system in terms of economic, cultural, historical and language specificity.

Further research in this field mostly arises from the limitation of this research which are at the first place mainly related to the selected sample of the population. It

remains unclear what variations would occurr with inclusion of samples from other Departments and other Faculties, which are in the same field of technical sciences but in different sub-fields, which leaves wide space for further research in the field.

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